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THE ST. GOTHARD TUNNEL.

The great work of boring a railway tunnel, nine miles and a quarter long, through the St. Gothard clump of the Alps from Göschenen, in the Swiss Canton of Uri, to Airolo, on the Italian side, was accomplished on Sunday, February 29, 1880. On the 28th of February, at 6:45 P. M., the auger of the Ariolo side penetrated the remaining stone wall, and hurrahs, vivas, the shaking of hands and embracing, all congratulated on the completion of this great work, and did not forget to speak of the merits of Louis Favre, who commenced this gigantic undertaking, but did not live to see it finished.

We give a number of illustrations and particulars, for which we are indebted to the *Illustrated London News;* also to the *London Graphic* and *Leipsic Illustrirte Zeitung.*

Fig. 1.—ST. GOTHARD TUNNEL.—ENGINEER BOSSI PASSES THROUGH THE OPENING.

this news was immediately telegraphed to Göschenen, Ariolo. The next day the directors, engineers, etc., of the tunnel assembled in the two ends to witness the final breach. At 11:45 A. M., eight deep detonations were heard, and as the smoke passed off, all rushed to the place of the explosion. The last partition had fallen. A hole about 2½ feet in diameter was found in the center of the same, about 3 feet above the floor. Engineer Bossi, the director of Favre's great undertaking, jumped through the same and embraced the section-chief, Stockalper, with great emotion. The engineer and workmen from Ariolo followed, and a memorable scene now took place. Among cheers,

The St. Gothard group of mountains is situated between the Simplon, to the east, and the Lukmanier and Splügen Passes to the west, rising above the head of the Lago Maggiore, and wholly in the territory of Switzerland. They contain the sources both of the Rhone and the Rhine, of the Reiss and the Ticino or Tessin rivers. The road across the St. Gothard Pass is the direct route southward from Luzerne, Schwyz, and Altorf, in Switzerland, to Bellinzona, Lugano, and Como, in Lombardy, and thence to Milan. The St. Gothard is about half-way from Zürich to Milan, in an almost direct line, and it stands in the most direct route from Basle, from Strasburg, from Calais or Ostend, and from London. As a convenience for English travelers to Italy, this new railway through the Alps will be much preferred to the Mont Cenis Railway, which owed its construction to the Piedmontese Government, under Count Cavour's bold and energetic administration, having been projected and commenced before the union of Italy in one kingdom. The tunnel through the Col de Frejus, commonly called the Mont Cenis Tunnel, is a mile and two-thirds shorter than that of the St. Gothard. The latter work was begun in September, 1872, and the boring of the Alps has thus been completed in seven years and a half; but it will be some months before all the works along the approaches to each end of the tunnel are finished and the permanent railroad is made ready for traffic.

The north end of the tunnel at Göschenen is 360 feet above the level of the sea, in the upper valley of the Reuss; and Ariolo, at the south end, 3,870 feet in elevation in the Val Bedretto, is at the head of the Upper Livinen, or Laventina, down which the Ticino flows to Bellinzona and the Lago Maggiore. The center of the tunnel is at an eleva-

tion of 3,779 feet. The St. Gothard road over the summit of the Pass was made about sixty years ago; it is safe and clear for traffic between May and October. The tunnel now opened has been constructed by a railway company, which undertook, in 1871, to make the whole line from Lucerne to Locarno on the Lago Maggiore, assisted by grants from the Governments of Switzerland, Germany, and Italy. There are several other tunnels and very steep cuttings on different portions of the line.

The plans were originally prepared by M. Helwag, as chief engineer, and M. Louis Favre was the chief contractor, who sublet the work of the tunnel, estimating its cost at two millions sterling, to several part-contractors. They have employed nearly 2,000 people, miners, smiths, carpenters, and engineers, to perform this work, assisted by the perforating machines and water-power supplied by turbines outside the tunnel at each end. The machines resemble those which were used in the Mont Cenis Tunnel, consisting of upright iron frames, which carry a series of piercing tools, set at the required height by screws and levers, and driven into the face of the rock by pistons working in cylinders with the force of compressed air behind them. Water was constantly injected into the holes, to soften the rock; and when the boring was done, to the depth of 3 ft. or 4 ft., and about 1½ inch diameter, the machine was drawn back, the holes were charged with dynamite, and the rock was removed by blasting. This could be done three or four times a day. The operations were carried on from both ends at once—a process which naturally demands that the plans of the engineers shall have been drawn with faultless minuteness. A deviation of one inch in the line within the first mile would have brought the workmen very far wide of their mark before the end of the thirty-sixth furlong was reached. As it is, the boring has been so correctly performed that the workmen from Airolo were, on Sunday week, shaking hands with those of Göschenen. It seems that these brave fellows have been toiling in a temperature scarcely lower than that in a hot-house, for, though the compressed-air machines are ingeniously contrived to furnish ventilation, it has been found almost impossible to carry currents of cool air down a shaft over four miles long. Under the circumstances, the work which the honest miners have done has been truly heroic; and nobody will grudge them hearty congratulations.

The last period of the work was naturally one of no little excitement. The first intimation the workmen on the Göschenen side had of the final stage was the fact that pieces of rock fell down without any assistance on their part. Then they listened, and heard the sound of operations on the Airolo side. Terrified lest an explosion should take place, they retreated as rapidly as possible to a distance. On reapproaching the head of the gallery they saw the Airolo borer and touched it; but it was heated to such a degree that they burned their hands. After the news had been spread on the Saturday night, no one thought of going to sleep. At any moment now the culmination of eight years' labor might be announced. At seven o'clock in the morning a train started from each end of the tunnel, carrying all the officials and their invited guests and friends. The machines were working on both sides, and when the guests arrived near the middle of the tunnel there was only one third of a meter of rock dividing them and remaining to be removed before they could meet. As it was from the Airolo side that the borer had penetrated through, it was arranged by means of the telegraph connecting the two ends that the Airolo men should have the honor of completing the last portion of the work.

Preparations were made accordingly, and at a quarter past eleven, the final blasting operations were performed, and after eight separate detonations, the last remnants of the wall of rock dividing the two portions of the tunnel were blown away, and with loud cheers the officials, workmen, and guests who had been working on either side, rushed forward and embraced each other.

The following particulars are from another source:

This tunnel is longer by 2,696 meters, or above 3,000 yards, than the Mont Cenis Tunnel, but has been got through in seven years and a quarter, whereas the Mont Cenis took thirteen years and a half. The principal engineer and contractor was the late M. Louis Favre, of Geneva, who died of apoplexy or heart disease last July, actually in the tunnel, in a visit of inspection. The length of the tunnel is 14,920 meters, or nine and a quarter miles. The dimensions of the tunnel are nearly identical with those of the Mont Cenis Tunnel. The height to the crown of the arch is 6 meters, or 19·68 feet; maximum width, 8 meters, or 26·24 feet; and minimum width, 24·93 feet. Various systems of construction are adopted, according to the nature of the ground. The highest part of the tunnel is 3,781 feet above sea level. M. Favre commenced working with Dubois and François rock drills, which were simpler than those of Sommeiller, by compressed air supplied by steam engines; but he afterward employed McKean's rock drills, and turbines to work the air compressors. The turbines were obtained from Messrs. Escher, Wyss & Co., of Zurich, three being placed at the Göschenen end, and worked by water from the river Reuss under a head of 279 feet. At the Airolo end of the tunnel three other turbines were placed, worked by water from the Tremola under a head of 541 feet. Compressors made from the design of Professor Colladon were employed, each capable of supplying about 700 cubic feet of air per minute, at a pressure of eight atmospheres. During the course of the work it has been found that the water supply from the Tremola was insufficient, and M. Favre had to bring water in an aqueduct 3,000 meters in length from the Ticino to work new turbines and for new compressors. This was about twelve months since; the new turbines were of cast iron, and when these were put in it was noticed that the older turbines, the wheels of which were in bronze in one piece, were, after making 155,000,000 revolutions per annum for five years, in excellent order, and only required their adjustments, for which means were provided. Sixteen compressors were employed at each end of the tunnel, supplying air for working from eighteen to twenty rock drills and for ventilation. Other compressors were employed to supply the compressed air locomotives with air at twelve atmospheres for removing the *débris* to the mouth of the tunnel. For removing the *débris* from the inner part of the workings to those parts served by the locomotive, horses have been employed; and as the temperature within the tunnel has been about 100° Fahr., it has been very deadly work for the horses, ten per month dying, on an average, out of a stud of forty. The rock consists chiefly of a hard granite gneiss, much fissured, generally free from water; but some trouble was experienced in this respect a few months ago. At the Airolo end gravel, sand, and pebbles were first met with; gypsum, talc, and mica schist were also found, succeeded by a dolomite. At about 286 feet from the end a bed of schist was pierced, which discharged torrents of water; after this was passed granite gneiss was entered. Some serpentine and other very hard beds have been met with, but that which has given as much trouble as any is probably the stratum of plastic material described before the Académie des Sciences by M. Colladon on January 12 last. This stratum materially impeded the progress of the works about four months since, as it transmitted the pressure of the superincumbent or adjacent material to the centering, and so great was the semi-fluid pressure that the very heavy granite voussoirs of the tunnel lining were frequently crushed. The McKean rock drills are capable of drilling as many as twenty-six holes 4 feet deep in a face about 6 feet 6 inches square. The holes having been charged with dynamite, and properly tamped, about 2¼ cubic meters have generally been dislodged. The progress of the boring has for some time been at the rate of from 20 feet to 24·7 feet per day. We have borrowed the above from our scientific contemporary, the *Engineer*, which gives sections of the tunnel and its masonry lining at different parts, with some technical details of construction.

It is needful to add some explanation with reference to the subject of the engraving opposite—namely, the hall which contains Professor Colladon's improved machines for compressing atmospheric air. This constitutes the power of expansive elasticity by which, as a substitute for steam power, all the perforators and other mechanical instruments are kept in motion throughout the tunnel and the works connected with it. The air-compressing department may, therefore, be called the heart, or the main-spring, of the whole system of operations at the St. Gothard Tunnel. It may, indeed, be equally regarded as the heart and the lungs; for it supplies the ventilation, the needful air for the workmen to breathe in the tunnel, as well as that which remains, in a highly condensed state, in the long tubes or conduits, or in the reservoirs, to form the motive power of the boring apparatus. The great hall of the compressors at Airolo, of which we give an illustration, contains twenty of those powerful compressing cylinders, most of them being arranged in sets of five together upon each stand, and worked by hydraulic force. This hydraulic force is produced by small turbines, constructed of bronze, on the Girard principle, each of which is of 200-horse power; and each turbine, when there is sufficient water, can work three of the air-compressing cylinders. The turbines are shown in our illustration, fixed on the top of their respective sets of compressors. They are supplied with water here by the Tremola, a stream which joins the Ticino lower down the valley; and likewise by an aqueduct from the Ticino, of which we have before spoken. The compressed air, having a density seven or eight times the ordinary density of atmospheric air, is stored up in a huge reservoir, 160 feet long, behind this building, and is thence conveyed into the tunnel by a line of conduit pipes, to which fresh lengths are continually added, extending all the way inward, through the boring of the mountains, to the new face of rock which has to be opened. Here is the movable frame, traveling upon wheels and rails, which carries a number of perforating chisels, adjusted by screws and shifting socket-holders, to pierce the holes for blasting with dynamite. There may be from twelve to twenty-six holes made in the rock, arranged in a fanlike shape, their depth being from 30 inches to 48 inches, according to the hardness of the stone. Water, from a tender which follows in the rear, is now and then squirted into the holes to soften the rock for boring; and the chisels, which soon become blunted, are frequently changed for sharper ones. The required series of holes being made, the whole boring apparatus is drawn back to a safe distance; the holes are charged with dynamite, and are then exploded by a long fuse; when the rock has been blasted, fresh air is poured in to clear away the gas and smoke, and the loose stone is quickly removed. Another length of rails being laid down, the boring apparatus comes forward again to make the attack upon a new face of rock. The space opened in this manner is not the whole width and height of the tunnel, but only a boring gallery, in the upper part of its length, about 8 feet high and 8 feet wide, and this is afterward enlarged by the ordinary mode of excavation. In some places, where the tunnel passes through soft and loose material, the boring and blasting process cannot be applied, and the work has to be done by hand, while substantial timber props and planking must be put up, lest the earth should fall in upon the men at their work. Among the sketches we have engraved are some groups of the patient, brave, and laborious Piedmontese, Savoyard, and Swiss workmen, by whom this great and difficult task has been achieved. Their sufferings from heat and foul air, getting worse and worse as they penetrated farther, a distance of four or five miles on each side, into the center of the mountain, were as severe, and as nobly endured, as ever those of soldiers in a prolonged siege or on the march, or those of sailors, Arctic travelers, or any desert explorers. The portraits of the two men, Neccaraviglia and Chisso, both natives of Piedmont, who had been employed in this tunnel from its commencement, and were formerly employed in the Mont Cenis Tunnel, are sketched at the bottom corner of the page. These men were chosen to have the honor of piercing the last thin screen of rock in the middle of the tunnel, and effecting the junction of the two working parties from its opposite ends, on the Sunday morning, the 29th ult., when that result was achieved. In other sketches we see the men fixing up wooden beams to support the roof of the tunnel, which will eventually be cased with a vaulting of masonry, or taking away the rubbish in a cart after blasting the rock. The men wear little clothing, as it is so hot, and carry rude lamps suspended by a cord from one hand. In the view of the south end of the tunnel, at Airolo, are shown the tube and a reservoir of compressed air, not unlike the boiler of a steam engine. The locomotives drawing trains of ballast wagons in the tunnel are worked by this compressed air, and so are the smiths' forges, and all the machinery, for coal is at a high price in that Alpine district, and steam would cost too much. There still remains a great deal to be done, both in the tunnel, which has to be enlarged to its proper dimensions, and in the lines of approach north and south. It cannot be opened for traffic in much less than two years from this time.

ON THE ABSOLUTE EXPANSION OF LIQUID AND SOLID BODIES.—For the entire scale of aggregate conditions one common law of expansion holds good. At the boiling and the melting points all substances possess an equal cohesion. If we therefore multiply the absolute expansion of the temperatures of these points, increased by the inverse coefficient of expansion (0·00365), we obtain comparable numbers which are all multiples of the coefficient of expansion. Probably the number of the atoms which combine to a liquid or solid molecular group stand in simple proportions in members of the same chemical group.—*H. F. Wiebe.*

THE RAILROAD SIGNALS NOW USED.

[From the Eleventh Annual Report of the Massachusetts Railroad Commissioners.]

RESOLVE IN RELATION TO THE USE OF SIGNALS ON RAILROADS.

Resolved, That the Board of Railroad Commissioners be instructed to investigate the subject of railroad signals, and to report the result of their investigation to the several railroad corporations in this Commonwealth, and to the next General Court. (Resolves, 1879, chap. 24.)

In conformity with this resolve, the Board gave extensive notice of public hearings, and have examined many models, and a greater number of working signals, on the railroads of this and other States. The great importance of the subject, and the attention given to it by railroad managers, together with its relation to other matters now under consideration, have induced the board to place their views in the body of the report.

BLOCK AND INTERLOCKING SYSTEM.

There can be no doubt that, for security from rear collisions, and from accidents occurring by reason of misplaced switches or open draw-bridges, the block system carried out by interlocking switches and signals comes nearer to insuring immunity from accident than any other known device. The block system, long used in England, and now brought almost to perfection by interlocking devices, is so called because under it each section of road is "blocked" by signals against the entrance of a train while that section is occupied by another train. Improving on the former system, which only provided for an interval of time between successive trains, the block system secured an interval of space. Under it a railroad was divided into telegraphic sections. Before a train could start from the first station, a signal was sent from the first to the second, and a favorable reply was received; then a signal was made for the train to leave station one, and at the same time station two was notified of the fact; this notification was acknowledged, and the section was "blocked" by a signal showing that it was occupied. When the train reached station two, a signal was sent to station one that the line was clear, and the "block" was taken off. Of course, if the train met with an accident, or if it was delayed in reaching the second station, the section continued to be blocked, and no other train entered it until a signal from the second station gave notice that the danger had ceased. And the same precautions guarded every section throughout the line.

THE INTERLOCKING OF SWITCHES AND SIGNALS,

combined with the block system, not only secures each section from the entrance of a train while it is already occupied, but also blocks the section for any train while the track is broken by the throwing of a switch, or by the opening of a draw-bridge, thus removing these causes of numerous disasters, while it allows a vast increase in the number of trains.

The method, in brief, is by the use of levers, operating switches and signals, so interlocked that a signal of safety cannot be given while danger exists, and a danger cannot exist until after it has been signaled. In other words, the operator cannot, by negligence or forgetfulness, or even from malice, create a danger or suffer it to exist until he has signaled it afar off to any approaching train. He cannot open a switch before setting a signal at danger; having opened a switch, he cannot leave a signal at safety; he cannot set the signal at safety before closing the switch; he cannot leave the switch half closed without giving a signal of danger. All these four errors, each of which has cost many lives, are made impossible in a section of road guarded by this system. And the boast is not extravagant that, for this purpose, the working of signals is not trusted to the intelligence or to the fidelity of a man, but that each man becomes part of an unerring machine in which his will ceases to operate, and he must act in accordance with the principles of its mechanism.

Mr. Barry, in his work on railway appliances, gives a strong illustration of the perfection to which mechanical provisions for safety have been carried. At Cannon street station in London 70 switch and signal levers are placed in one signal house, making millions of combinations possible, if they were not interlocked. Of these combinations only 808 are safe. Yet a stranger blindfolded or blind, handling these levers at random, cannot produce a condition of danger. He could stop trains and hinder business, but he could not create a possibility of danger without signaling it in advance.

More than this—because the pulling of the wrong levers, although not causing immediate accidents, does strain the machine and thus might lead to the unlocking of the levers, with consequent disaster; therefore, the attempt and bare idea of pulling the wrong lever is checked by mechanical means, and the uncertain will of man is subordinated to the perfect mechanism of this device.

In operating this apparatus two systems of signals are used, one near the cabin or tower of the operator, and one at a distance sufficient to enable a train to be stopped after the signal is seen and before entering on the blocked section. The semaphore is used by day for a signal, as being the one distinguishable at a greater distance than any other form. At night colored lights are used. Mechanical means may be employed for short distances; electricity serves for long distances. To supplement the signal, if it should be obscured by fog or darkness, a "contact bar" is sometimes used which, with the danger signal, assumes a horizontal position, and, by striking the cab of the locomotive, gives a warning somewhat like that given by the bridge guards, which strike the person who is exposed on a freight car.

The working of this system for draw-bridges is the same as for switches. The draw cannot be opened until the signal for danger has been set. The signal of safety cannot be given until the draw has been closed and actually locked.

By uniting the interlocking device with the block system it becomes impossible to telegraph safety from one signal station to the station next in the rear until all the switches are in a safe position for a coming train. It is impossible to move switches so as to allow access from a siding to a track which has been telegraphed as safe for a coming train. It is impossible to so move the switches, or any of them, after the line has been telegraphed to be blocked. It is impossible for a train to enter a section until its coming has been announced by telegraph, for the signal to enter cannot be given until a signal announcing its approach has been received. The signal which permits entrance into a section cannot be given without the concurrence of signal men at both ends of the section. The starting signal is reset at danger by machinery behind every train. The signal that the line is blocked must be given from the station in advance to the station in the rear.

This summary, in substance, is borrowed from a description of the combination of the Toucey and Buchanan with the Saxby and Farmer devices, which, aided by some sub-

FIG. 2.—THE ST. GOTHARD TUNNEL.—PROF. COLLADON'S AIR COMPRESSORS.

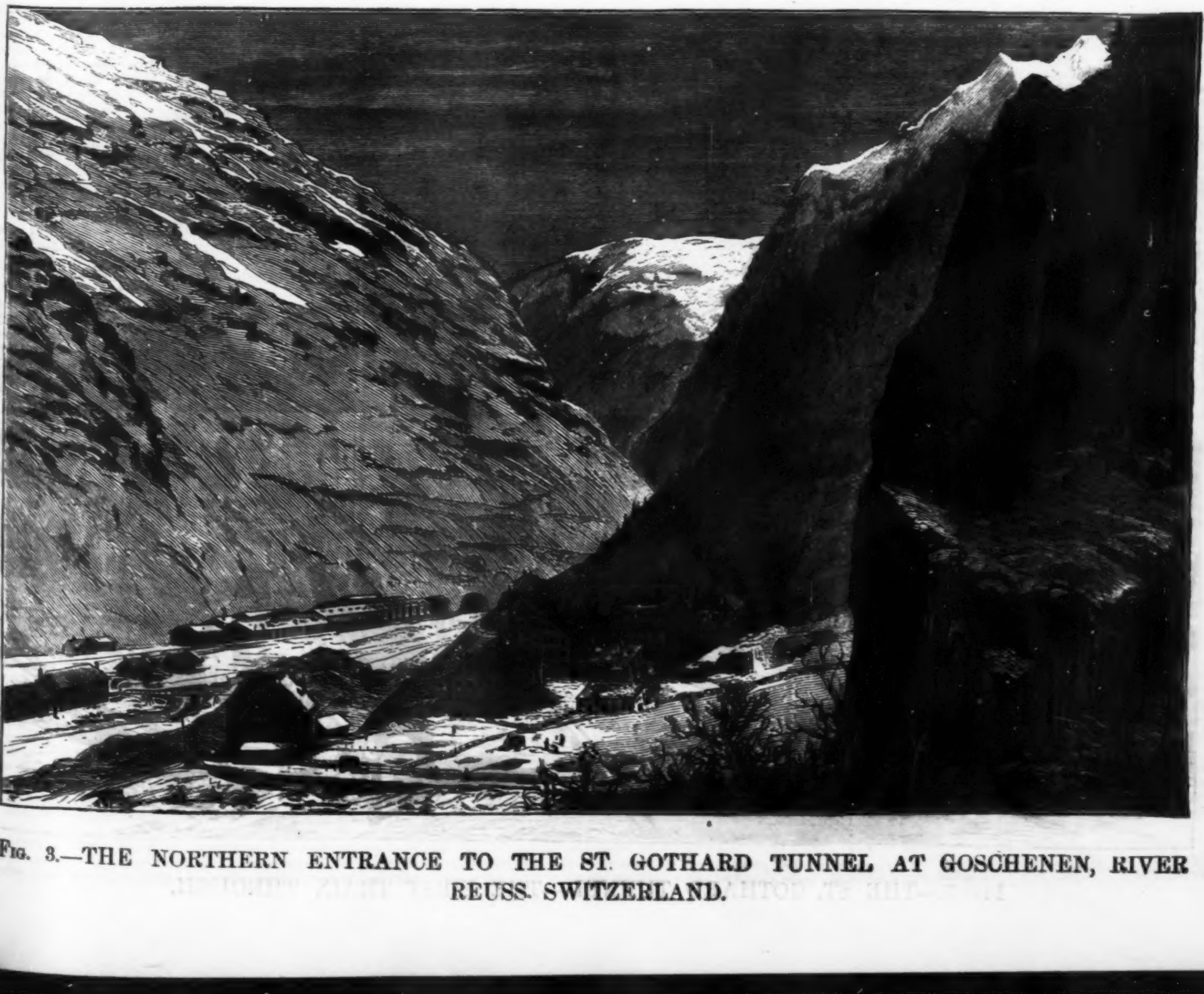


FIG. 3.—THE NORTHERN ENTRANCE TO THE ST. GOTHARD TUNNEL AT GOSCHENEN, RIVER REUSS. SWITZERLAND.

FIG. 4.—THE COMPLETION OF THE ST. GOTHARD TUNNEL, FEBRUARY 29, 1880 -THE MEETING OF THE WORKMEN.

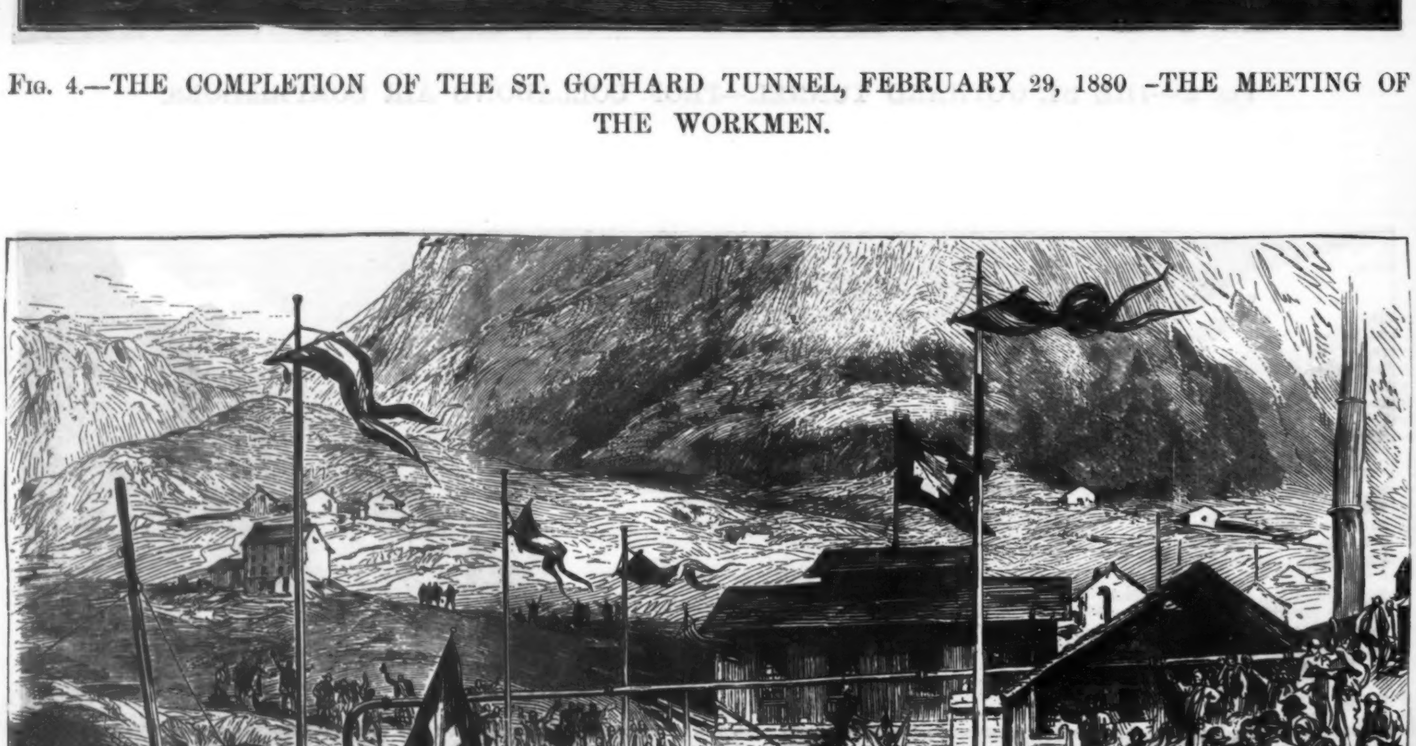


FIG. 5.—THE ST. GOTHARD TUNNEL.—THE FIRST TRAIN THROUGH.

ciliary inventions, are now in use on a portion of the Pennsylvania Railroad and on the Metropolitan Elevated Railroad in New York, as well as elsewhere.

The ingenious device of David Rousseau, involving the same principles and accomplishing the same end, may be seen at the New York Grand Central depot. The members of the board have seen the operation of these inventions at those points, and their daily working vindicates the high claim made on their behalf. It will be a happy day for travelers when this system, in all its completeness, has been universally adopted on American railroads.

But the block system, as operated with interlocking devices in England and France, and as used with additional improvements on portions of American roads, requires a large body of skilled and well-paid men. For an unskilled operator, although he could not cause danger, would cause delay and difficulty. Our inventors, therefore, have tried to supply its place by automatic signals, guarding a road and giving warning of danger without the constant intervention of man. And it is claimed by some of them that their inventions are not only more economical than the English system, but that they are safer. In the language of one of these inventors: "My device is better than a man, for it is always on hand; it never sleeps and it never drinks."

As a preliminary remark to a discussion of automatic signals, it may be observed that it is a requisite of any system that the normal conditions of its signals should indicate danger, so that in case of any derangement of apparatus, accidental or intentional, warning will be given. Thus, failure to act will at most stop or check the movement of a train. It will never cause a disaster. A device that fails in this particular fails at the outset. It is also absolutely requisite that the danger signal should be given far in advance of the point of danger. A signal displayed at or near the point of danger is utterly insufficient and unsatisfactory.

HALL'S ELECTRIC SIGNAL

is the best known and most widely used. He employs an open circuit, and the current which keeps his signals set at safety is transmitted over wires. This current, being broken by an engine entering a section and touching a circuit closer, sets the signal at danger.

1. As a safeguard from rear collisions, theoretically at least, it approaches perfection. The danger signals are set a mile or less apart, and a red disk shows that a section is occupied. A secondary signal, sometimes called a tell-tale, is placed a thousand feet in advance of the danger signal, and informs the engineer whether the danger signal behind him has been set. When the engine passes out of a section, it sets the signal of safety for that section. If the current ceases to work from any cause, a signal of danger will be given. But absolute perfection has not yet been obtained in the construction of the apparatus; and the passage of a train sometimes fails to set the signal of danger; yet, in that case, the tell-tale will indicate danger. And so it cannot happen that both signals belonging to a pair will indicate safety when danger ought to be announced.

2. Station agents, by a separate device, can arrest the progress of a train at a distance of half a mile by a signal of danger.

3. The connection of switches with this system makes it impossible to open a switch so connected without blocking the track by a signal. This occurs at a distance of two thousand feet, more or less; and at the same time a bell rings at the switch, and continues to ring until the switch is closed.

4. The application of this system to draw-bridges appears to secure perfect safety. It is impossible to open a drawbridge without blocking the track by a distant signal; and, if the engineer fails to see or recklessly disregards the blocking signal, then another signal will arrest his progress—a mechanical drop, constructed of heavy plank, placed 2,000 ft. from the draw, and so arranged that it falls by gravity when the draw is opened; and, if the engineer still presses on, his locomotive is sure to lose its smoke-stack, and he yet has time to check his train and escape disaster. The working of this device was curiously illustrated when it was first used on a road in New York; for the train men, having a prejudice against it as a novelty, determined to disregard it; and more than one engineer, bringing in his locomotive without a smoke-stack, gave the best evidence of his own recklessness and of the merits of the invention. Now that draw is opened 130 times a day, and it is approached without fear of accident. Two other adjuncts furnish additional safeguards in approaching a draw-bridge guarded by Hall's signals—a bell ringing at the distance of a mile when the draw-bridge is opened, and a signal given to the bridge-tender if the train enters the blocked section.

5. The notice given to passengers and agents at stations, by bells differing in tone for "up" and "down" trains, announcing the approach of a train, is convenient, and tends to prevent accidents. For its purpose it is a perfect device, while it saves the great annoyance of whistling.

6. Highway crossings at grade are guarded by a bell or gong placed at the crossing, which begins to ring when a train approaches within half a mile, and continues to sound until the train has passed. This calls the attention of the flagman or gate-keeper to his duty. And if the sound were loud enough, it would arrest the attention of travelers and warn them of the coming danger. Some device of this kind has been heretofore urged by this board, and their views are repeated in their report on the Lincoln accident (Appendix E). With such an appliance, giving an alarm sufficient to command attention and always in working order, there would be absolutely no excuse for an accident at a crossing, unless it happened to be a man blind as well as deaf; for not only does the bell sound, but a signal to stop is displayed to the eye automatically while the danger continues.

But such a device, in order to be depended upon, must be without the possibility of failure, and neither in theory nor in practice can this be said of Mr. Hall's crossing-signal. The ringing is done by the positive action of electricity put in operation by the passing of a train. If the apparatus is out of order, no current is produced and no warning is given. The principle that danger should be indicated, unless something positive happens to prevent it, is not carried out in this part of Mr. Hall's invention. And in fact we learn that such an apparatus, placed withih the limits of Boston, does occasionally fail to announce a coming train. Its use, therefore, is only auxiliary, and it will not, as it now exists, allow railroad managers to dispense with other safeguards at highway crossings.

The objections urged against Mr. Hall's block or track and switch signals, apart from their cost, are mainly these:

(1.) It is said that they are so delicate and complicated that they often fail. This, to be sure, when the failure is of electric current, does not directly result in an accident. It only delays a train. Each double-track road has orders directing the time of delay on seeing the signal of danger—a time necessarily brief, say one minute—and after this the train proceeds "with caution." But the tendency of frequent false alarms is to reduce the amount of caution, and the cry of "wolf" too often repeated may make it unavailing when danger really comes.

(2.) It gives no warning of a broken rail, and does not profess to give such warning.

(3.) Neither does it give warning of a car left on the track by a passing train—an accident not unusual, especially with freight trains. On the contrary, in such a case, the engine, with the portion of a train attached to it, passing off from the obstructed section, sets the signal of safety and lures a coming train into danger by a false announcement. Something like this happened recently on one of our Massachusetts roads. An engine was sent after dark to take five cars from a siding, push them on the main track, and then haul them away. There proved to be six cars, which were pushed from the siding, and when the five were hauled away one unoccupied car remained on the main track. A passenger train afterward left the station and came in collision with this car. Fortunately, the result was not serious; but it illustrates a danger against which Mr. Hall's signals do not profess to guard.

(4.) So it is said that a train on a guarded section, followed by another train proceeding with caution, would, on passing off, set the signal of safety. The second train breaking down from some defect of wheel or like cause, would remain as an obstacle and possible cause of collision with a third train coming on the section with the assurance of a clear track given by the signal. This, however, could never occur unless the second train were allowed to enter a blocked section, nor without gross carelessness on the part of those in charge of that train in neglecting to flag the section.

THE UNION ELECTRIC SIGNAL,

hitherto little tried in actual working, professes to do away with all these objections and to guard against all the dangers which Mr. Hall leaves unguarded. Its fundamental difference from his system is that it uses a closed circuit, with an electric current moving through the rails; and this current holds the signal at safety, from which it is moved to danger by mechanical means whenever the current is checked, whether by the dangers intended to be guarded against or by some accident to the apparatus. Thus, in all its operations (as in most of Mr. Hall's) a failure to work gives warning of danger, but no failure can entice a train into peril. The circuit through the rails is made more effective by wires connecting each rail with the next, and firmly fastened at every joint. This was found necessary because the oxidization of the rails interrupted their conducting power. Each section is insulated by the use of vulcanized fiber. This seems to be effectual. The mechanical means by which the signal is given in case of a broken current is a simple clockweight, so arranged that it runs for several days, giving passage for 600 trains before it runs down. The current is produced by a battery, and in cold weather a kerosene lamp, burning for a week at a time, is used to keep the liquid from freezing.

When a section of road is guarded by this device, the entrance of a locomotive breaks the current simply by placing its wheels upon the conducting rails, and thereupon visible signals of danger are given, and when the train approaches a station or crossing a warning bell is rung. So excellent is its working that a piece of wire laid across the rails breaks the current and sets the signal of danger; and a stray goat, dragging his chain after him across the track of the Providence Railroad, recently gave the alarm as of a coming train to the gateman at Forest Hill crossing. A secondary or telltale signal, in this system, informs the engineer at once whether or not his train has given warning. And station agents have the means of warning a train that is entering on a blocked track. This device is considerably cheaper than Mr. Hall's, and it is claimed that, being simpler, it is less likely to be out of order. But it certainly has these more important advantages:

(1.) As a crossing signal it indicates danger in case of any accident to the apparatus. The failure of a battery, the breaking of the apparatus by accident or design, would of itself give an alarm, while in such case, as has been said, the Hall device would cease to work and trains would pass without warning. It is claimed also that it has this incidental advantage: Under it the bell is sounded by mechanical means, which are released by breaking the electrical current. And so the ringing may be done more powerfully than when it is effected by the direct power of electricity, which is variable, and which, as practically used, is supposed to be feebler than the cheap mechanical power applied by clock motion. But the soundness of this claim has not been demonstrated by any exhibition made to this board. And no crossing signal of this system has yet been exhibited which seems calculated to arrest the traveler's attention as thoroughly and certainly as it should.

(2.) The breaking or displacement of a rail, by interrupting the current of electricity, gives a signal of danger, provided the displacement of the portions of the rail is sufficient to cause such interruption.

(3.) It indicates the presence of a car on the track by whatever means it came there.

The invention has not been used nearly as much as Mr. Hall's. Its proprietors, therefore, cannot refer to so many witnesses as to its working. Probably it is just to add that, for the same reason, there may have been fewer criticisms on its defects. As has been suggested before, there seems to be this advantage in using a closed circuit, that it requires less from electricity. The labor of this system is done by gravitation, and electric force is only used to control it. Electricians are accustomed to say: "The less you ask of electricity the more sure you are to get what you want." In the present state of science this is no doubt true.

Among the possibilities of failure with this signal is neglect to wind up the weight, which would prevent any signal from being given. Some, also, object to the need of lighted lamps in cold weather; but failure of a lamp, resulting in the failure of a battery, would set a signal of danger. On one road, where a few of these signals are used, frequent breaking of the wires is complained of as giving needless signals of danger. The Fitchburg Railroad Company has had the signal on five miles of its road for more than a year, including the whole of last winter. Since May it has been in charge of the officials of the road, and their report is highly favorable. If it works well through the winter, it will have had that full and continued testing which such inventions need before they can be commended with entire confidence.

ROUSSEAU'S SAFETY RAILWAY SIGNAL.

This signal has already been referred to as used in blocking the New York Central and Hudson River, where it has been in successful operation for nearly four years. It resembles Hall's system in many points—among others, in using an open circuit. It resembles the Union electric signal in using gravitation as the power which actually gives the signals, thus requiring a less powerful battery than the devices where electricity does the direct work. The signal is set by a clock weight, and when wound up it signals 350 trains before it needs winding again. By an ingenious device the lamp on these signals cannot be removed for trimming without winding up the weight.

As in the inventions described before, the engine, when it enters a section, sets the signal at red, meaning danger, and it so continues till the train has passed off, when it sets it at clear, meaning safety. Each of these effects is produced by a "commutator," over which the wheels pass. In places of extra-hazard, two danger signals are used—one, called a distance or cautionary signal, 1,000 feet in advance of the signal within the section that is to be entered. If this distance signal shows green (or any color selected for the purpose) it indicates that the second signal is red; and the engineer must stop before entering on that blocked section. This system also provides each station-master with the means of stopping any approaching train, if danger has been shown to exist; and an indicator keeps him acquainted with every movement on his section of the road. An extra signal, to be used in foggy weather or in dark tunnels, is a rod which not only strikes the engine, but, by an additional device, causes the whistle to sound; and, it is said, it can be applied to the brake and made to stop the train. The long use of this signal in the Harlem tunnel is relied on as proof of its excellence. The application of the system to switches and draw-bridges needs no explanation; and the application of all these systems to a single track, while it presents points of difficulty, is a matter of detail which need not be discussed.

BEAN'S ATMOSPHERIC SIGNAL

is a safeguard against the dangers arising from open switches and draw-bridges; and it is also applicable to stations and crossings. A brief account of this device is given in Appendix G. The Old Colony road has tested this device by using it at exposed points for more than two years, gradually increasing the number of instruments in use, and now having them working at distances varying from 1,000 to 1,400 feet at one draw-bridge, two stations, and four switches. This signal is simple and inexpensive; and, so far as it has been used, and for what it undertakes to accomplish, it seems to be an almost faultless device.

In the appendix also may be found tables showing some results of the working of Hall's and of the Union electric signals; also brief accounts of devices which were exhibited to the board, but which are not subjects for full reports, because they have not been put to the practical test which is needed before such report can be made.

In conclusion, it is evident that the time has not come when the adoption of any one of the devices exhibited for giving automatic signals should be required by law. No party has asked for legislation; and Mr. Hall strongly disclaims any desire for legislative action. Nor, pending further experience on the part of railroad men, and further experiments by electricians and other inventors, can it be thought strange that railroad companies hesitate to equip their roads fully with imperfect devices, which may soon be set aside for better. Many ingenious men are giving their thoughts to railroad signals. The laws of the force, which most of them are trying to use, are not fully known, and the force is not capable of entire control. The railroad managers of England, and indeed of Europe, are more than skeptical as to the use of automatic signals, electric or otherwise. They would regard reliance upon such signals as criminal recklessness, if they were not supplemented by other appliances. Many railroad men in this country share this feeling; and this refers not only to railroad managers, who might be suspected of being influenced by undue economy, but to skilled superintendents and other experts who have no such motive. At present, no one has the right to say of any system of signals, as a whole: "This is the system that ought to be adopted on all roads." The desire is natural that some tribunal should decide at once which is the best, and that the Legislature should order its adoption. But the time for such a decision has not yet come, even if any automatic device can ever be found which will alone answer all the purposes of a safety railroad signal.

Yet it should be remembered that these imperfect devices do render great service in announcing danger and preventing accidents. The worth of a safety signal is to be estimated chiefly, not by counting the number of its false alarms, but by its well-founded alarms. Even an occasional failure to give warnings of danger, while it forbids sole and implicit reliance upon an automatic signal, does not prevent its being of great value as an auxiliary. When the terrible consequences of a railroad disaster are considered, a preventable accident becomes a crime. The public have a right to expect that their safety will be guarded by every reasonable precaution, and that devices designed for this end should not be rejected simply because they have not attained perfection. Railroad managers should be quick to guard their tracks, and especially all draw-bridges and other points of special danger, by those appliances that seem to them best adapted to insure safety. It is proper to add that our chief railroad companies have shown a praiseworthy spirit, both in testing new inventions and in adopting those that, upon trial, have commended themselves to their judgment.

WEIRS AND DAMS IN INDIA.

To the Editor of the Scientific American:

In your No. 25 (Dec. 20, 1879), I notice your article on "The Great Chanoine Dam at Pittsburg.

Your readers may feel interested in learning what has been done in this country (India) in that line.

In the year 1864, I constructed a movable weir in the center of the dam which is across the Mahanaddy River in Orissa, and which was the first ever tried in this country. The dam itself is nearly a mile long, and 12 feet above the bed of the river.

The movable weir being nearly in the center, these ten openings are left 45 ft. wide, separated by piers 5 ft. thick and 10 ft. high.

These ten openings are closed by seven shutters which fall down flat upstream, and are 7 ft. 6 in. high.

Each shutter has two anchor chains 1 in. dia. attached to a teak beam let into the masonry, and strongly bolted to the floor, the shutter itself being hinged to another beam 15 in. square, also well secured to the foundation flooring. Along the front beam runs an iron round bar of 2¼ in. diameter, which carries for each shutter 2 fingers, which, by partially revolving the bar by a hand-lever at the end and close to the pier, locks on to plates on the shutter, thus keeping the shutter from rising.

To the beam to which these front shutters are hinged, seven corresponding shutters falling down stream are hinged—these being 10 ft. 6 in. high. When raised to a

nearly vertical position, they are kept up by a wrought-iron strut, and the intervening space of about half an inch is filled by the mid-web of a $3\frac{1}{2}$ in. T iron, which is also hinged to the wooden beam, and also strutted into place, acting as an additional support to both shutters.

The following is the way in which the shutters are worked: If we commence during the dry season, the back shutters, 10 ft. 6 in. high, are up, and the front one down and locked, the water being then nearly level with the top of the back shutter. The rainy season is at hand and the river has commenced to rise, the struts are released, and one by one they are lying flat, and the whole opening is clear for the flood waters. Thus bay after bay are severed until the whole ten are open, giving a clear water way of 450 feet.

The dam, which is, as before stated, nearly a mile long, has on its crest a series of shutters 3 ft. high and about 25 ft. long each, and these are now all leveled, and so remain for two or more months, or until the rains have ceased and the river begins to fall.

The level of the water will then be equal in height to the crest of the dam.

Commencing at No. 1 bay: the lever is manipulated; the two fingers of the first shutter removed; the stream acting on it lifts it into a nearly vertical position, and it is there held by the two anchor chains.

The fingers of the next, or No. 2, shutter, which are slightly longer, are now removed, and thus two out of the seven are up, and so on until the whole bay is closed by the front shutters, after which the remaining nine bays are in a similar fashion closed; the whole operation taking about half an hour, and closing 450 feet, through which the stream had been running at five miles or more per hour.

Men now are sent to lift into position the back shutters; the struts are made secure; the T irons make all tight, and the river level commences gradually to rise. The 3 ft. high shutters on the crest of the dam are raised, and in a day or two the level of the surface water is up to the top of 10 ft. 6 in. shutters.

When this is accomplished the 7 ft. 6 in. front shutters fall in the still water in front of the 10 ft. 6 in. back ones, and are then locked into that position ready for again assisting to close the vents.

This system has been successfully worked for the last ten years upon the Mahanaddy River, also for the same period on the Beropa River, where there is only one vent, nearly 200 ft. wide and 10 ft. 6 in. high, and closed by 25 pair of shutters.

Since then I have effected very considerable improvements in the details of this system, and will, if you so wish, furnish you with drawings.

The first improvement is the A strut, hinged at the bottom from the back shutter with a very sensitive catch, by which a man on the piers can let down each shutter consecutively.

The second is a continuous hinge which prevents leakage at the bottom, and is of immense strength, and prevents stones, sand, or gravel, from interfering with the action of the shutters.

The third improvement was in making both shutters and beams of iron, as it has been found that those made of wood have been eroded by the sand and water to such an extent that their renewal now is necessary.

I may now conclude by stating that, within the last five years, I have erected for the Government of India shutters with the improvements I have above noted on the Brambini River, across which there is a dam about a mile long, with about ten vents of 50 feet each on the right bank, and ten vents of 50 feet each on the left bank, and 10 ft. 6 in. high. Also the Byturni River, which is about half a mile wide, has a dam across with similar vents fitted with double shutters, and the Burri River, which has also a dam across, and is about half a mile wide with similar vents and shutters.

I shall be glad to furnish any further and more exact information to any one requiring it.

G. H. FAULKNER, C. E.,
Late ex-Engineer D. P. W.,
Bengal Irrigation Branch, Calcutta.

January, 1880.

FARCOT'S NEW CONTINUOUS FURNACE FOR GAS DISTILLATION.

M. E. DENIS FARCOT exhibited at the recent Industrial Exhibition, at the Champs-Elysées, Paris, a new apparatus, represented herewith, and which is designed for manufacturing illuminating gas by the distillation of coal or other materials rich in hydrocarbons. The peculiarity of this apparatus consists in certain new arrangements, by means of which coal or other products to be distilled are kept in constant circulation, thereby insuring a continuous production of the gas. An examination of the figure will be sufficient to make it understood how this new distilling furnace works. An iron plate reservoir, closed by a hydraulic-jointed cover, receives a charge of coal sufficient for several hours' distillation. This reservoir ends at its lower part in a conical orifice, which empties into a rectangular chamber. When the coal reaches the latter, it is carried up in a very regular and uniform manner into the distilling apparatus by means of a chain and buckets. The distilling apparatus consists of a vessel made of cast iron or refractory clay, closed by a cover, which is provided with an opening. Within the interior of this vessel there revolves very slowly a circular plate mounted on a vertical axis. The coal brought up by the chain and buckets falls upon the plate through the upper orifice and is carried along with it until it meets a partition, which stops it and directs it toward the aperture, through which it falls into the receiver. The vessel which serves as a retort is heated by a coke or coal fire: and the residues of coke may also be used by injecting air by means of a blower. On falling upon the plate heated to redness, the coal distills during the circular route that it is obliged to take. The speed of the chain and buckets and that of the circular plate is so regulated as to introduce only the quantity of coal that can be distilled at a single revolution of the plate. The coal is thus deprived of its gas, and is converted into coke, which then falls into the receiver filled with water, and is extinguished. From the receiver the coke is raised by means of a chain and buckets, and loaded in wagons to be taken away. The products of distillation on issuing from the retort are purified by the methods in general use. The gas produced may be used for illuminating purposes, for heating, or for supplying gas engines.

ACID RUBIN.—Dr. E. Jacobsen converts the hydro-chlorate of rosanilin into a sulphacid by acting upon the anhydrous salt with chlorinized sulphuric acid, SO_3Cl. This compound is an exceedingly valuable agent for the production of sulphacids. It acts less violently than the fuming sulphuric acid commonly employed, and yet forms sulpho compounds with ease. The coloring matter thus produced can be used in woolen and silk dyeing in acid baths, and can be advantageously associated with extract of indigo, etc., for the production of various browns, modes, etc.

THE LACE MANUFACTURE OF CALAIS.

THE manufacture of lace goods by machinery, which at present is of considerable importance at Calais, or rather in its suburb St. Pierre, dates from the year 1816, when the first loom was surreptitiously imported from England, for, at that time, a prohibition against the export of machinery existed. At present two or three of the oldest factories of Calais date from 1825.

Unlike Nottingham, Calais has had great difficulties to overcome in obtaining the yarn required, for, until some years past, the necessary fine counts were not spun in the country, and had to be got from England, notwithstanding a very considerable import duty. The latter was in fact so prohibitive that the greater quantity of the yarn was, until 1860, smuggled, a proceeding which was winked at by the French Government to favor the Calais manufacture.

The goods made in 1825 were really not lace, but only *tulle* made by machinery; lace goods as such were not produced until the Jacquard machine became applicable in 1840 and enabled manufacturers to produce designs of greater or less elaboration. At the same time the looms were improved so as to contain more shuttles, which ran quicker, and the production was still more increased by the invention of the circular loom.

During the reign of Louis Philippe the manufacture of lace spread to other towns, such as St. Quentin, Douai, Lille, and Lyons; in the latter town, especially, where most of the silk tulle was then made, while Calais and St. Pierre made lace goods of all textile fibers, including silk, worsted, and cotton, but its chief production at that time were lace curtains.

At the time of the Anglo-French treaty, Calais had 633 looms, while there were 6,000 at Nottingham; this number rose to 939 in 1870, while more than 419 looms were running in the other places in France, and these mostly on coarser goods. This increase of the number of looms in Calais was principally caused by the manufacture of silk lace, to which since then its attention has been principally devoted, for here the French could meet the English manufacturers even-handed.

At present Calais, with St. Pierre, possesses 1,600 looms, valued at £720 each, with all accessories, or including buildings, etc., at £880 each, thus representing a capital of £1,600,000. These 1,600 looms are distributed amongst 430 manufacturers, who produce annually about £2,000,000 worth of goods, of which three-quarters are silk and one quarter cotton goods, a great part of which is exported. These looms give employment to 1,000 hands working on silk, and 600 working on cotton, while only 3 or 4 remain for worsted laces.

The silk used comes mostly from Lyons, and ranges from No. 20 to 340, while silk waste is used from No. 4 to No. 80, French counts. The cotton goods are made of two-fold yarn, ranging between No. 40 and No. 340, English counts, and even higher. The goods made of cotton are mostly imitation Valenciennes, torchon, point lace, Malines or Brussels, bobbinet, etc.

The price of the raw material forms generally one-half of that of the manufactured article, both in silk and in cotton, though in the latter it sometimes is considerably more, as, for instance, in bobbinets, where it mounts up to 70 per cent. For this reason there are only 30 looms running on the latter fabric, while there are 500 in England.

Each loom gives employment, including all accessory labor, to about 20 persons, which gives a working population of 32,000 hands depending upon this industry, a colony by no means to be despised, and of the existence of which no doubt many English travelers on their way to Paris never had the remotest idea.

The 1,600 looms are very unevenly distributed among the 430 manufacturers, and there are many who have only one or two. The perfections which are continually introduced into these looms make it imperative for the larger manufacturers often to replace old ones by those of the newest construction; the former are then sold to smaller men, and sometimes, in a short time, change hands two or three times, each time at a lower price, and thus gradually come down from fine expensive goods to others of plainer kinds. For this reason it is also no uncommon thing to find different manufacturers with one or two looms, separated from each other by only a wooden partition in a large mill where they rent the power. The largest manufacturers, of whom there are only two or three, have as many as from 15 to 18 looms.

Much more has to be allowed in this kind of manufacture than usual for depreciation, for on account of the frequent renewals of the looms they can only be considered of full value for a short time. On the other hand, all other expenses have also to be calculated unusually high, for the goods are subjected to very great fluctuations in price, and a lace which to-day may be sold at three shillings a yard may not be worth more than threepence 18 months hence. Much depends, as in all fancy goods, upon the beauty of the designs, which, in many cases, come from Paris. A good design may thus command a comparatively high price, and be a source of revenue, while, with a design which does not take, all the labor of setting and gaiting has been lost. The great aim of all lace manufacturers by machinery is to imitate as closely as possible the more costly real laces made by hand; even the best, when examined closely, show a great difference between the two, but much of this disappears when placed upon the person, and especially when upon an otherwise expensive and handsome dress, and the old Roman saying, *mundus vult decipi*, still holds good.—*Textile Manufacturer.*

CONCERNING AMBER.*

By ERMINNIE A. SMITH.

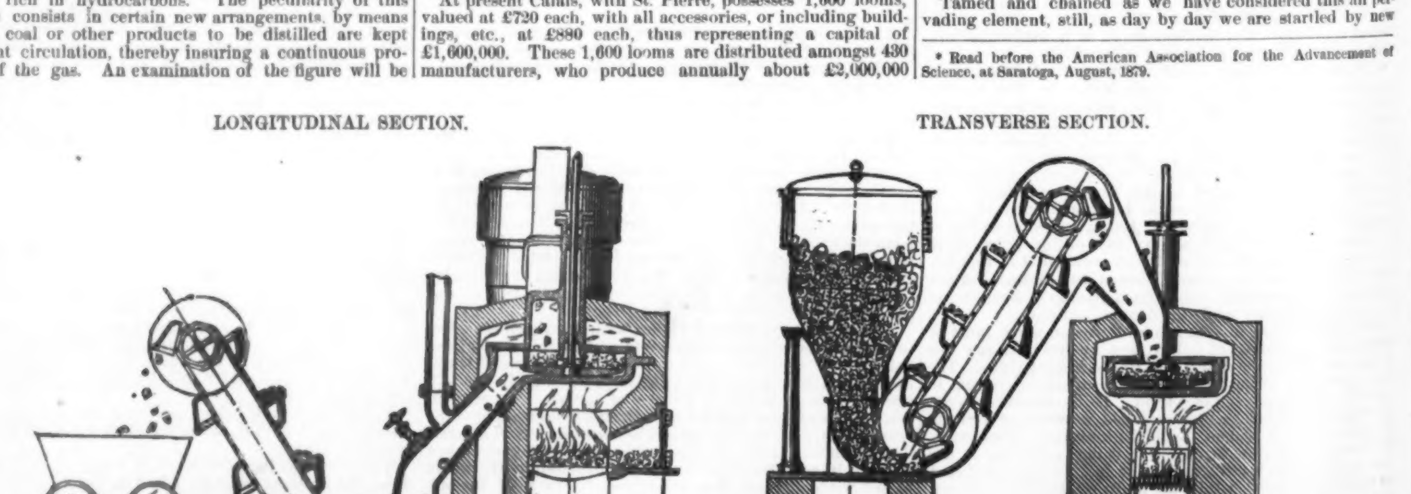
THE history of amber illustrates most clearly not only the slow and tedious growth of civilization, but also the seeming perversity and obtuseness of human nature, which, especially in former times, so retarded the advancement of science. Exhuming this history from the dim, far distant prehistoric past, we find that from being first used for fuel by the almost barbaric northern hordes, among the more refined southern peoples, amber, like bronzes and their other articles of luxury, took the place of coin and had its economical and financial import. The oldest written documents that have come to us mention it as one of the chief articles of luxury of the ancient civilized world, an object of greater request than fine gold.

Three thousand years ago it was well known among the inhabitants of Hellas that amber would attract light bodies, and Thales, one of the "seven wise men of Greece," adduced that circumstance in support of his theory that inanimate objects possessed souls, but two and a half thousand years passed before it was discovered that it was this selfsame power which, flashing amid the roar of thunder, illuminated the wide canopy of Heaven, bound iron to iron, and directed the silently recurring course of the magnetic needle.

Tamed and chained as we have considered this all pervading element, still, as day by day we are startled by new

* Read before the American Association for the Advancement of Science, at Saratoga, August, 1879.

LONGITUDINAL SECTION. TRANSVERSE SECTION.



FARCOT'S CONTINUOUS FURNACE FOR GAS DISTILLATION.

discoveries, and while awaiting the result of investigations which may transform the night of our great metropolis into day, are we not as puzzled that these problems should have remained so long unsolved as astonished at their solution?

Americans can complacently pardon the inexplicable fact that Dr. Wall, the English scientist, when succeeding in drawing the electric spark from amber and hearing the crackling sound accompanying it, compared the two to thunder and lightning, but left the discovery of their being identical to our Benjamin Franklin with his kite and key.

Although nearly two thousand years ago, Pliny wrote that amber was the fossil resin of the extinct Conifer, *Succinum pinites*, to-day the subject presents many unsolved problems. It is true the modern geological column has assigned it an approximate geological place, and modern chemistry has given it a formula, and its principal scientific value as the source of succinic acid and varnish.

A brief review of some established facts in regard to amber, as also some of the erroneous but probably received ideas, which, if unimportant, still remain uncorrected, will perhaps show that for a substance ever popular, coveted as a luxury, even ranking as a gem, both useful and ornamental, with a name in every language expressive of its many qualities, it has scarcely received the attention it deserves.

Probably the oldest of these names is *bernstein*, or its equivalent in the old Teutonic, from its combustibility. Its two Latin names are *succinum* (juice) and *lincurium*. In Persian it is called *körnbu*, or straw robber; in French the trivial name is also *tire de paille*, from its attracting straw; in Italian, Spanish, and English nearly the same name is given for amber, signifying cluster or mass. The first Greek name applied to it was a term signifying the rays of the sun, either from the color or some relation to the sun god. The popular Greek name was *electron*, or the attractor, and thus one substance can boast of having added a word to nearly every language, as even the mother-tongue-loving Germans find *electritat* more euphonious than their harsher synonym, *bernsteinkraftigungrüstzeug*.

Italy, Spain, France, Switzerland, and England are given as amber-producing countries, but it must not be forgotten that under this name are included many fossil resins, the differences in which have as yet been hardly determined. In Lemburg, in the Tertiary sandstone, with giant oysters, a splendid amber is found in immensely large pieces, clearer than the Prussian, and producing a most delightful odor when burnt.

In the pitch coal of Bohemia, Reutz found specimens containing sulphur, and also with the foraminifera of the Vienna Tertiary. Daubré found amber in Alsace, and Schubert in the Alps, but these were of a different quality from that of the Baltic Sea. But there is no doubt that this amber conifer forest reached from Holland over the German coast, through Siberia and Kamtschatka even to North America, and from the abundance of amber found in some localities, those conifers must have been as productive as is at present the *Dammara australis* of New Zealand, the twigs and branches of which are so laden with white resin as to have the appearance of being covered with icicles.

One of the great deposits of amber is in the Hauptvaterland, where on the plains of Pomerania the peasants dig in the surface clay for it. In the vicinity of Brandenburg, pieces have been found weighing four pounds.

From this abundance of amber in the drift clay and also from the fact that branches of "arbor vitæ" (*Thuja occidentalis*) occur in the Baltic amber, and have been found in the stomach of the mastodon in the United States, Göppert concluded that the "Diluvial," or time of the mammoth in the Old World and mastodon in the New, was the age of amber.

This theory has since been entirely disproved.

By far the most celebrated locality for its richness in amber, and one which still possesses great stores of this valuable fossil, is the peninsula of Samland—a portion of Prussia nearly surrounded by the Baltic Sea.

The northern part of this region, which constitutes the promontory of Brüsterort, is very hilly, and the coast banks are often from one hundred and fifty to three hundred feet high. Formerly this was all owned and worked by the German government, and was watched by *gens d'armes;* all amber found, even by the peasants in plowing, being claimed, the finder, however, receiving one-tenth of its value. For the piece in the Berlin Museum, weighing eighteen pounds, the finder received a thousand dollars.

Until ten years ago, during stormy weather, when the waves were beaten against the bank of this coast, the amber was thrown up in quantities, entangled in the seaweeds, and a hundred hands were ever ready to intercept it with their nets, a trying occupation, as the roughest storms yielded the richest booty. Of late years the diving apparatus has been used so successfully that the marine deposit has been greatly diminished, and systematic mining is now carried on inland, where the amber is much finer.

The price of amber has increased during the last year, and this advance is caused by the diminution of the yearly product, many of the pächters, or renters, having thrown up their contracts and abandoned the business of mining on that account.

It was in this famed locality of Samland, so favorable for geological survey, that Prof. Zaddach, of the University of Königsberg, pursued his investigations relating to the birthplace of amber, and his report throws great light upon this vexed question.

Taking a section of the cliffs where the geological structure is exposed, he finds that wherever the Tertiary formation crops out, it always comprises two different deposits. The underlying consisting of thick beds of glauconitic sand, which sometimes attains a height of sixty feet above the sea level, and upon this rest the beds of the Brown Coal formation, from sixty to a hundred feet thick. Under the green sand lies the so-called amber earth, only from four to six feet thick, and underneath this the "Wilde Erde," so called because containing no amber.

Sometimes the beds of green sand are cemented by hydrated oxide of iron into a coarse sandstone which often contains well-preserved fossils representing the Tertiary period, but as this glauconitic sand is a marine formation, it follows that the amber it contains does not lie in its original bed—that is, not in the soil of the old forest in which the amber pines grew—but that the amber was washed into the sea in which sea urchins and crabs lived.

In the sand of the amber beds are found numerous pebbles or pieces of compact stone, which is evidently the parent rock of the green sand, as it is composed of exactly similar granules of quartz bound together by a marly cement. The amber earth also abounds in fragments of rock known as chalk marl, which contain Cretaceous fossils.

The same rock is found on the island of Bornholm in the Baltic, and belongs to the Cretaceous. It is therefore proved that the Tertiary glauconitic sand has been made up of the green sand of the Cretaceous formation. Therefore the trees yielding the amber resin must have grown upon the green sand beds of the Cretaceous which then formed the shores of the estuary where the lower division of the Tertiary accumulated. Zaddach assumes that at that time the coast sank slowly, and the forest soil being washed by the waves the amber was carried into the sea.

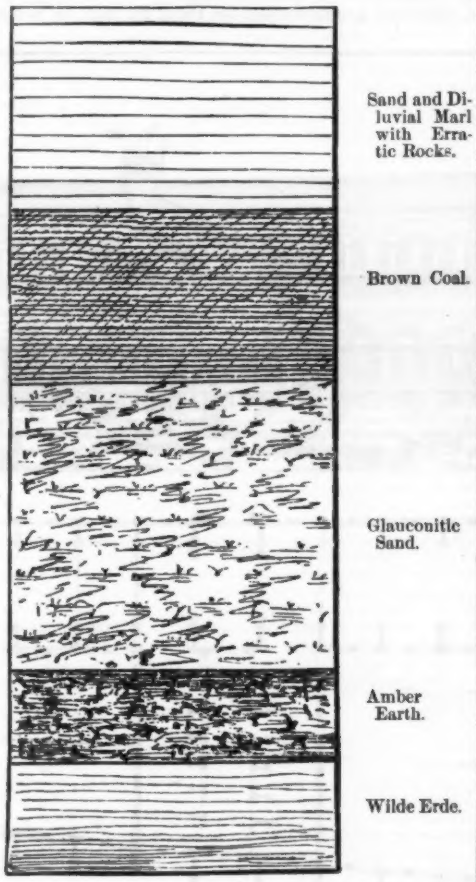
Immediately over these amber-producing strata rest the beds of the Brown Coal formation, the fossil plants of which differ entirely from the amber flora. Finally, Prussia was laid dry by an upheaval of the rocks, and this ended for a time the recorded history of the country.

Now ensued a new period in the geological history of Samland, when the climate and all the conditions of the country were changed. The mountains of the north which projected out of the sea were covered with glaciers that extended down to the water.

Icebergs laden with the finer *débris* of rocks and blocks of stone were detached from these glaciers and drifted to the south, passing over land formed of Cretaceous strata. Without doubt there remained a considerable deposit of amber upon this green sand bed of the Cretaceous formation where the old forest soil still existed. By the icebergs this soil was now broken up and the amber brought down and scattered in every direction.

Thus the fact is explained that amber nests are found in the quaternary deposits over all the plains of northern Europe.

This epitome of Prof. Zaddach's report seems to settle the question as to the birthplace of amber in Germany, and contradicts entirely the generally received opinion that it is the product of the Brown Coal formation, and also the theory



GEOLOGICAL SECTION OF THE AMBER COAST OF SAMLAND.

of Dr. Feuchtwänger, that marine amber was a later deposit or formation than terrestrial.

It is apparent that the gum of the amber trees flowed out as a viscid sap, to which all small objects, leaves, twigs, insects, etc., that came in contact with it adhered. Subsequent exudation covered these and preserved them more perfectly than was possible by any other method. In this way vast numbers of insects were hermetically sealed up, over eight hundred species having been discovered and many groups yet remaining to be studied.

These give us much interesting information in regard not only to the insect life of the amber age, but afford valuable information in regard to the history of many of our living species and groups (see Heer's description of amber insects). These species are now mostly extinct, but have affinity with tropical forms. A very interesting collection of these most ancient mummies can be seen in the British Museum. A classic spider is at Amherst, and in my own collection is a lizard so perfectly embalmed that the animal tissues can be seen, as also the liquid contained in the stomach; this little curio has the honor of having been christened by Prof. Agassiz.

Prof. H. R. Goeppert has made a study of the remains of plants found in amber, and has identified one hundred and sixty-three species, all of which are now extinct. Mr. Kaldenberg, of New York, has specimens of amber containing bark, water, and various insects.

After mining, amber is kept temporarily in vaults near the amber localities. Rosa narrates that he entered one of the vaults of the Pächter Douglas, where he saw the yearly products arranged according to their size and quality in chests and baskets, and saw records containing the yearly results back to 1500. The worth of the pieces varies according to the size and perfection.

For the trade it is divided into classes, the best pieces being generally sent in the rough to Constantinople, where they are used for the mouthpieces of pipes, as it is still believed there that amber possesses properties preventing contagion, and as the pipes of this ease-loving people are lighted by domestics, the amber tips to the long stems are considered a prudent caution. The trade with Constantinople is very ancient, and still continues over the same route as a thousand years ago.

The smaller sized pure pieces are used for beads, and the very impure for the distillation of succinic acid, the residue or refuse is the *colophonium succini* employed in the preparation of varnish. The varnish made from amber has long been considered the finest, but other resins are now its rivals, and varied are the secrets of this prosperous trade. With amateurs at work all over the land we may hope that even the secret of Stradivarius may yet come to light!

The chemical analyses of all resins, both fossil and recent, differ very slightly, certain varieties of amber, copal, mastic, etc., giving nearly the same atomic ratio, as will be seen from the following table:

	Carbon.	Hydrogen.	Oxygen.
Amber	10	8	1
Retinite	12	9	1
Copal	10	9	1
Mastic	10	8	1
Eliminite	10	8	1
Fichtlite	8	6	1
Ambrite	16	13	1

The conclusion is that their differences consist in the arrangement of their molecules and not in their composition or even age.

Amber may be distinguished from the other resins by its hardness, its lesser brittleness, and the much higher temperature required to reduce it, and also its greater electric action, but the difference is quickly discovered in the attempt to cut and polish, as the ordinary resins become in the process so heated and softened as in a measure to prevent their use for ornamental purposes. Copal jewelry is, however, occasionally made, but it soon loses its luster.

A property of amber not generally known is its flexibility at certain temperatures. Formerly when amber required bending it was softened by placing it in warm linseed oil, and it could then be bent into a required form. For changing the form of amber the method at present used in one extensive manufactory in this city, is simply to hold the amber over a lamp and draw it out slowly by hand. Although this process is very difficult and slow, the results are marvelous.

A pipe-stem nineteen inches long has been in this way drawn out of a coil of amber about six by four inches in size or fifteen inches in circumference.

At the same factory can be seen all the process of working amber which, owing to its low degree of hardness, is wrought with the turning lathe after having first been cut with a knife and filed into something approaching the form required. It is then polished in the lathe or by hand with pumicestone, whiting, and alcohol. The chippings and amber dust left from the cutting are used for varnish or incense. The Orientals, especially the Chinese, consider the burning of the odoriferous amber the highest mark of respect possible to pay a stranger or distinguished guest, and the more they burn the more marked is their expression of esteem.

We find in King's work on gems the following: "A large amber cup, holding half a pint, has lately been discovered deposited in a tumulus in Ireland, which, from its size, could hardly have been cut out of a single block of that substance. It has been ascertained by experiment that bits of amber boiled in turpentine can be reduced to a paste, united and moulded into any form desired."

In Feuchtwänger on gems, we also find similar assertions regarding the melting and reforming of amber. Both King and Feuchtwänger are in error on this point. If amber were ever thus melted and moulded, the art has certainly been lost.

Repeated experiments have failed to produce such a result, although a recent German scientific journal informs us that a patent for such a discovery has been applied for. An art so valuable, if successful, would certainly insure a fortune to the inventor. Nor is it necessary to have recourse to such a theory in order to account for the cup exhumed from the Irish tumulus. Alexander, Czar of all the Russias, owns a tea-set cut from blocks of this precious material. I have seen rough specimens both in the Berlin and Vienna museums larger than would have been required for the cup alluded to.

The imitations of amber are various. Glass paste is sometimes used; another composition is of turpentine and caoutchouc; still another, linseed oil, gum mastic, and litharge, to which finely powdered copal is added to give the appearance of veins; add to this, arts of decalcomanie, and we have the material of the cigarholders which so deceived the uninitiated during our Exhibition at Philadelphia. The most perfect imitation is the uncolored celluloid. Abbé Haüy gives the following mode of detecting or identifying amber: "Attach a fragment to a knife, and when inflamed the amber will burn with some noise and ebullition, but without liquefying so as to flow, whereas all other resins and compositions melt and drop." A better method is perhaps the electrometer.

Very little amber has as yet been found in the United States. Gay Head, Martha's Vineyard, Camden, N. J., and Cape Sable only are mentioned as its localities. A barrel full of small pieces was taken out of the green sand in New Jersey, which through some mistake was burned.

Let us hope for the accident which may yet reveal to us hidden stores of this interesting substance with a less primitive fate in reserve for it.

While the color of amber is generally yellow it occurs in all shades, from pure white to "black." The *Falernian*, from the wine of that name, was the favorite color among the Romans. Dice of the white variety are hardly distinguishable from ivory.

At Constantinople a pipe-stem of the milk-white variety is prized by the Turks at from forty to a hundred dollars. The action of sulphuric acid on the yellow changes it to red. A beautiful specimen of green amber has been found on the American coast. "Black amber," which was a vexed question in the middle ages, returns to question us again to-day. Monsieur le Conte de Borch, in his letters from Sicily, within the last decade, says that "black amber is common."

Stretter, the latest English authority on gems, also gives black amber; but a very careful analysis of the black amber which has recently been imported from Spain to be manufactured in New York, gives: Carbon, 82·57; hydrogen, 7·70; oxygen and nitrogen, 9·08; ash, 0·65. A result so different from true amber, and on distillation yielding no succinic acid, is, therefore, not true amber, but either a superior variety of jet or a highly oxidized bitumen. In chemical

composition it seems to occupy an intermediate position between cannel coal and torbanite.

Subjected to the microscope, woody fiber is visible, replaced in part by resin. Its electric power is great, and admitting as it does of a remarkable polish, its lightness well adapts it for ornamental purposes.

Among the old accounts of journeyings in search of amber, we find the first mention of the Teutons as a race. As the search for an "El Dorado" led to voyages of discovery in later times, so we find that voyages and pilgrimages to the land of amber were made dating back to 1,500 years before Christ. Peschel says, "Preach aloud the fact that the migrations of nations depend on the existence of the substantial treasures of the earth." So this Prussian paradise had been visited by Pythias of Massilena, four hundred years before Christ, also by Theophrastus, the naturalist and philosopher, and by Philomen, the Greek poet. Nero sent there his Roman knights, who brought back quantities of amber to enrich his treasury, and a small image in this precious material was valued higher than a human slave.

Amber was intermingled with the myths and religion of the Greeks, their legends ascribing its origin to

"* * * The sweet tears shed
By fair Heliades—Apollo's daughters,
When their rash brother down the welkin sped,
Lashing his father's sun team, and fell dead
In Euxine waters."

Amber literature is of great interest to the virtuoso. Books in all languages refer to its many supposed qualities, and the insects contained in it have given rise to many quaint metaphors which still exist. Martial (A.D. 43) wrote in Latin: "The bee is inclosed and shines preserved in a tear of the sisters of Phaeton, so it seems enshrined in its own nectar. It has obtained a worthy reward for its great toils—we may suppose that the bee itself would have desired such a death."

Milton apostrophizes a bee in amber, and Moore revels in amber imagery.

Modern authors have written of the weird "amber witch," and of "amber gods," and to-day a lizard in amber is thus addressed:

"Who pinioned thy grotesque and uncouth frame
Within the sunshine of this golden chamber?
Is this the fountain whence the nectar came?
Or is it star born, this undying flame
Which men call amber?

"Splay-footed sprawler from the unknown seas,
Oh, tawny cousin of the Ichthyosaurus—
What sportive sister of Hesperides,
In the ambrosia of celestial trees,
Embalmed thee for us?"

So questions the poet, but if we might invoke this "Ancient Mariner" from out his crystal coffin, more serious would be the questions we would bid him solve.

But though speechless, he bears a silent witness, for as one of the many hieroglyphics of the language of geology, underneath its Rosetta wand, he helps to reveal the history of our earth.

Thrice happy the gifted mortal, who, wielding this magic wand, can lift the veil and translate these mystic symbols of the too long "dusky past."

Thomas May (1640) thus translates this:

"Here shines a bee, inclosed in an amber tomb,
As if interred in her own honey comb—
A fit reward fate to her labors gave,
No other death would she have wished to have."

Hay in the same century translates it thus:

"The bee inclosed and through the amber shown,
Seems buried in a juice that was her own;
So honored was a life in labor spent,
Such might she wish to have her monument."

Sir John Denham (1640) wrote of streams,

"Whose foam is amber and whose gravel gold."

In the Nibelungen Lied we find Hagentronje with his amber girdle; the dragon's blood armor of Siegfried is also supposed to have been amber; and Brunhilde mentions the amber-colored flower.

Byron alludes to amber in the "Island," and Pope speaking of Sir Plume,

"Of amber snuff-box justly vain."

Also in his prologue to the Satires,

"Pretty in amber to observe the forms
Of flies and ants and bees and bugs and worms;
The things we know are neither rich nor rare,
But wonder how the d—l they got there."

THE BRUSSELS PERMANENT EXHIBITION.

DURING the current year Belgium will celebrate, by a series of brilliant fetes, the fiftieth anniversary of her national independence.

The occasion has also been chosen for the opening, at Brussels, of a permanent exhibition of the arts and sciences and the commercial and individual products of all nations. The building for the Exhibition was begun in 1875, and in an ambitious structure called the Palais der Midi, or South Palace. A birdseye view of the palace, with a plan, is shown in the accompanying engravings. The building is centrally situated between the Boulevard du Hainaut and the Avenue du Midi, two of the principal thoroughfares of Brussels.

The triple purpose of the Exhibition is:

"To make known every production, invention, or manufacture by its own publicity, and the advertisements made by the administration;

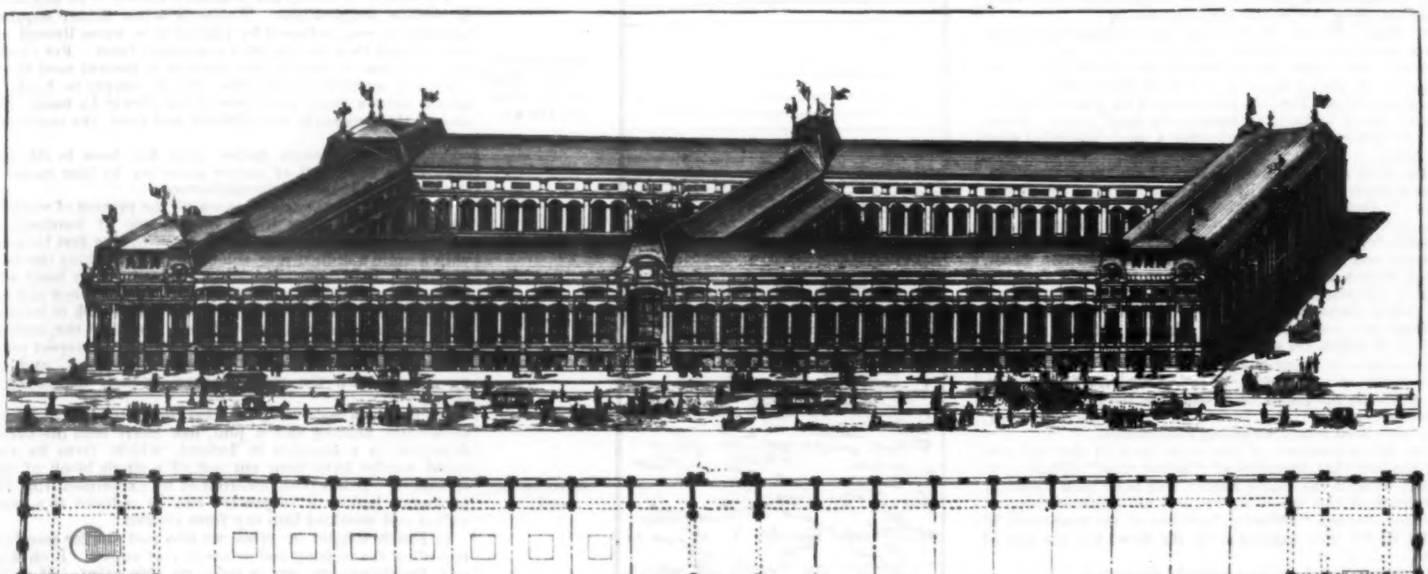
"To show the exact nature of the articles referred to in this publicity;

"And finally to form a bond of union between the consumer and producer and bring them together to their reciprocal advantage and profit."

In plain English, the plan proposes a grand bazaar for the exhibition and sale of all sorts of products except dangerous or explosive materials.

"The administration will undertake the reception, the preservation, and the sale or disposal of all the articles or productions exhibited, of their delivery to purchasers, of all the details and particulars relative to the exhibits under their charge, and faithfully care for the interests of the consignors."

The space will be rented upon conditions to be arranged with the administration, payments to be made semi-annually in advance, at the annual rate of 50 francs a square meter of surface and 25 francs a square meter for wall space. Special charges are made for space in the machinery annex. Motive power and all mechanical appliances are furnished by the administration. All communications should be addressed to M. de Bavay, General Manager-Director, Palais du Midi, Brussels.



PERMANENT INTERNATIONAL EXHIBITION, BRUSSELS.

LOST AT SEA.

DURING the year 1879 forty-nine ocean steamships—all but four of which were constructed of iron, with water-tight compartments—thirty-seven of which had been built since 1870, and four of which were less than a year old—were lost at sea. In addition, 45 ships, 146 barks, 48 brigs, and 277 schooners were lost in one way or another, and the sum of these disasters in money value is given by the underwriters at $15,000,000, and in human lives at 511 souls. This is an impressive record, and particularly that portion of it which relates to the loss of ocean steamships. Of these, twenty foundered or were abandoned at sea, fourteen were sunk in collision, nine were wrecked or stranded during storms, and the remainder were destroyed by fire, explosion, or agencies unknown. The very large proportion of which there is no record save the simple word "foundered" is terribly suggestive of some fatal fault either in the construction of the vessels or the manner of loading. Six steamers—all built of iron, ranging in burden from 1,100 to 2,250 tons, and all loaded with grain—were never heard from after leaving port; and in the case of others that are supposed to have foundered, the crews did not survive to tell the news, and the evidence of the fact was derived from the known whereabouts of the unlucky vessels at a certain time and their disappearance before completing their voyage. Nearly all of these steamers were ranked high in the Lloyds: they were all comparatively new, as we have said, and there is no reason to believe that they were inefficiently manned. The conclusion seems warranted, therefore, that their loss was due to causes connected with the cargoes which they carried—either to overloading or to the shifting of cargoes at sea producing a strain upon the vessels that they could not withstand. It is significant that of the lost steamships fifteen were loaded with grain, which being shipped in bulk, is peculiarly liable to displacement during a storm, and thus may endanger the safety of the soundest and most seaworthy ships. Some modification of the manner of stowing away cargoes in bulk seems required to lessen the present risks of marine insurance and protect the lives of the officers and crews of our merchant marine. Mr. Plimsoll has done a great work on the other side of the ocean by his crusade against rotten ships, but the statistics which are here presented would seem to indicate that there is another source of peril which equally demands investigation.—*Baltimore American.*

LIGHTNING CONDUCTORS AND THE PROTECTION OF ST. PAUL'S CATHEDRAL.

WE lately had occasion to review a book on the subject of "Lightning Conductors," in which the author, Mr. R. Anderson, has brought into convenient compass the existing theories and systems. We there referred more particularly to the system adopted at the Hotel de Ville, Brussels, one of the best-protected buildings in the world, to which Professor Melsen's method of numerous small rods with points and good earth connections, is applied. There can be little doubt but that a perfect metallic connection in which all the metal in the building is brought into relation with the rods and earth is the secret of protection from electrical discharge;

but, like every other application of physical science, the art of protecting buildings by conductors has been one of slow growth, the best improvements have been the results of experience and disaster. For instance, the old plan of terminating the rods with balls quickly fell into disuse from experience, and the point termination took its place. So with the old iron rod conductors: when they were used it was soon found that the rods rusted at the socket connections, and the lightning was conducted into the building from finding no continuous conveyance to the earth. The experiments of Sir W. Harris, Faraday, Touldas, Du Moncel, and other electricians, and the conclusions that have been drawn from the actual injury caused to edifices by imperfect modes of protection, have taught some practical lessons to the electricians in charge of buildings.

We allude to the subject again to draw attention to the success which has attended the application of conductors to St. Paul's Cathedral, a work undertaken in 1872-3 by Mr. John Faulkner, of Manchester. Though there have been many severe thunderstorms since that time, we understand that the structure has never been injured by lightning, and that the recent examination and test of the conductors made by Mr. Faulkner in October last year proved satisfactorily the perfect working-order of the system, and the protection of the Metropolitan Cathedral from lightning. It may not be out of place to briefly recall the time, not many years since, when St. Paul's Cathedral was practically without efficient protection from the shafts of electrical agency, and this, notwithstanding the numerous masses of insulated metal on its summit and roofs. It is true that a committee of the Royal Society, about 120 years ago, undertook the erection of a set of iron rods or conductors, which to a large extent protected the building; but it was found that oxidation had dangerously impaired their efficiency. The stanchions at their connections were found quite rusty, and in many cases, we are informed, where the stanchions had been left by the old committee connected to the iron hoods of the rain-pipes, stone hoods have been substituted, leaving the electric current to pierce some six or nine in. of dry granite. In 1872 this state of things continued, and St. Paul's was pronounced to be a model till the report of Mr. John Faulkner, Associate of the Society of Telegraph Engineers, opened the eyes of the Dean and Chapter. Thereupon Mr. Faulkner was appointed to prepare a plan for an efficient system of conductors, which plan has been carried out with the results we have already stated. Mr. Faulkner's plan consists of bringing into metallic connection every portion of the building that has metal, and in connecting these with the moist earth. To describe this in his own words; "In the metallic connection, with cross, and ball, and scrolls, are eight copper conductors, each being a half-inch strand of copper-wires. The octagonal strand has been adopted as giving most metal in the least space. These eight conductors pass to the metal railing of the golden gallery, with which they are in metallic connection. Thence they are carried down to the dome, to the metallic surface, of which they are again connected at several portions of their length. Then down the rain-falls over the leaden roofs of the aisles, in the angles formed by the aisles themselves, again down the rain-falls to the sewers. Further the choir and nave roofs are connected together by a saddle, or conductor stretching over them both, and joined to the conductors proceeding from the summit of the west towers." To show what care was expended over the work, the lead sheets of the roofs were tested one by one, the worse insulated sheets being connected by copper bands to the better conducting surfaces. It will be observed, therefore, that the dome, ball and cross, nave and aisle roofs, and the two western towers, are so connected that they form one immense metallic conductor. The conductor, or strands, are led into the sewers, to afford a moist earth connection, the strands being riveted to copper plates, which are pegged into the earth. The advantage of frequent inspection and testing the conductors must not be disregarded. The method of testing adopted by Mr. Faulkner is simple, and by its means every square yard of the roofing has been tested to insure perfect earth-connection.

Even now there are misconceptions as to the requirements of buildings as to the shape and size of the conductors, the mode of attaching the rods, the proper kind of insulator, the sort of connection with earth, and the proper number of conductors necessary for the protection of certain buildings. Bearing upon the last point, it may be as well to remind the reader that Arago observed that the zone protected by a conductor may be limited by a circle whose radius is equal to twice the clear height of the point above its last bearing. In 1878, the Institute of British Architects, the Meteorological and one or two other societies appointed delegates to consider the subject of protection of buildings, etc., from damage by electricity, for the purpose of preparing a code of rules, and we have no doubt, from the details of buildings injured by lightning and various other data that they are collecting, a few plain and practical rules for the guidance of both the architect and electrician will shortly be established. The position and proper connection of metal guttering and other metallic surfaces, the effects of large masses of metal in the building, such as stoves, the influence of chimneys, etc., are important points that demand settlement, and it would be as well to know the least number of conductors a building of considerable area, and with several lofty summits or towers, ought to have to protect it from the stroke of an electric discharge.—*Building News.*

YELLOW FEVER.

Dr. José de Goès, of Rio de Janeiro, has been successful in his treatment of yellow fever by the dosimetric method, employing granules of strychnine, hyoscyamine, and cafeine, and keeping the bowels in order with the Chanteaud-seidlitz. We have also before us several other successful results of the same method by Dr. Da Sylva. If this should be confirmed by the experience of others, of which, after reading these accounts, we can have little doubt, it will prove of enormous benefit to the inhabitants of the tropical regions.

Yellow fever, or vomito negro, is a bilious miasmatic affection of the most intense nature; but instead of being an algid fever like cholera, it is on the contrary characterized by heat. The body is burning hot; there is intense headache and pain in the loins; the dejections are of a blackish color on account of the decomposition of the blood. When the exacerbations have been quieted by strychnine and hyoscyamine, they must be prevented from returning by means of the granules of arseniate or hydroferrocyanate of quinine: 10 to 12 granules per diem, and even more where necessary. Such is the treatment which has given such satisfactory results in the hands of Dr. Josè de Goès, who has recently, we understand, presented an extended report upon this method of treatment to the Brazilian government.

Dr. Da Sylva's treatment is similar to the above; he first clears the intestinal tube by salts of magnesia (citrate of sulphate), then administers granules of arsenious acid and arseniate of quinine, as antimiasmatics, aconitine, and digitaline as defervescents; arseniate of strychnine and phosphoric acid as tonics; with arseniate of soda and arseniate of iron as reconstituents of the blood. He has described with full details a dozen cases treated by the dosimetric method in 1875, of which one is doubtful and two succumbed; all the rest were cured within a very short period.—*Monthly Magazine.*

THE TURKISH BATH.—WHAT IT IS, AND WHAT IT DOES.

By John Stainback Wilson, M.D., Physician in charge Medical, Hygienic, and Turkish Bath Institute, Atlanta, Ga.

So wide is the scope of modern therapeutics, so numerous are the "new remedies" constantly brought to our attention, that it is impossible for a single individual to test their virtues. This is especially true of such an agent as the Turkish bath, which must, from its nature, remain to a considerable extent in the hands of specialists, but which, at the same time, should be known and understood by the people, so that they may enjoy its benefits and duly appreciate its advantages over many other remedies. Hence this article.

Something resembling our modern Turkish bath was known to the Greeks, Romans, and other nations of antiquity; and the Turks now have baths which give name to ours; but the baths used by the ancients and by the modern Turks differ from those in use in Great Britain, the United States, and the Continent of Europe, both in their nature and objects.

The bath of these countries is a *dry hot air* bath, given in rooms of different and graded temperatures, and while often resorted to as a luxury, is regarded less in this particular than as a remedy.

The scientific remedial use of the modern improved, hot-air, high and graded temperature Turkish bath can be properly dated back only about twenty years ago, when it was introduced into Great Britain by Mr. David Urquhart. Since then its use has rapidly extended in this country and in Europe, and the verdict of the most distinguished authorities is, that it is a therapeutic agent unequaled in safety, in efficacy, in the extent of its applicability to the treatment of disease, and in the correctness of its principles, as tested by modern science. While it is not a panacea, such is its physiological action that it may be safely said that it has a wider range of application than any single remedy or combination of remedies.

PROCESSES OF THE TURKISH BATH.

Every Turkish bath should have at least four rooms: a cooling room; a tepid room with a temperature of from 110° to 140° Fahr.; a hot room, with a temperature of from 150° to 200°; and a wash or water room of a comfortable temperature—say from 60° to 80°. These graded temperatures give the Turkish bath a great advantage over any other kind of bath. In the tepidarium a gentle and general perspiration is solicited by the warm dry air acting on the skin, and through the lungs, all undue excitement and determination to the head being obviated by a hot-water foot bath, and by the application of a cold cloth to the head. The circulation having thus been equalized, the bather then passes into the hot room, raised to what might at first sight be regarded as a temperature intolerably and dangerously high. But all such ideas will be dispelled by remembering that this room is filled, not with steam, but with *dry warm air*, which can be breathed at a temperature of 150° or 200°, or even higher, not only with impunity, but with positive benefit and delight, while a steam bath at a temperature of 110° or 115° is intolerably oppressive and suffocating. In this hot room the shampooing should be done, while the body is bathed in perspiration and everything is all *afloat.* This is the only way in which the matters embedded in the seven millions of pores can be dislodged; and at the same time, it is the most prompt and effectual means of removing impurities from the blood and the internal organs.

THE PHYSIOLOGICAL AND THERAPEUTIC ACTION OF THE TURKISH BATH.

Every one will readily see that the greatest point of excellence of this bath is the immersion of the whole body, including the head, in *dry warm air,* thus acting not only on the two thousand square inches of the skin, but also, on the twenty thousand square inches of the lungs. This air being rarefied by heat and lighter than ordinary air, pressure on the capillaries is correspondingly diminished, the blood rushes to the surface, where its fluid portions, with all the impurities suspended in them, are greedily absorbed and dissipated by the dry air. How different this from a steam bath! In the latter, the air, being already loaded with moisture, cannot take it from the bather; and therefore perspiration to any considerable extent is a physical impossibility. How different, too, the action on the lungs! The warm dry air of the Turkish bath can be breathed with positive delight to the very bottom of the lungs, permeating their deepest recesses, and acting on the irritated or inflamed air passages very much like a warm fomentation on an external wound. On the contrary, the air passages are spasmodically closed against the ingress of the vapor of water, the bather is well nigh suffocated, and the good effects arising from the inhalation of warm air are lost. This last difficulty holds equally in the box vapor bath, with the head out; while the physical obstacle to perspiration before mentioned exists in this bath, as in the Russian bath in which the room is filled with steam.

The functions of the skin and their importance to health are too well known to detain us with their consideration. Magendie, Foucault, and other physiologists have proved that coating the skins of pigs, dogs, and other animals with any impervious substance results in asphyxia, disease, and speedy death. Foucault has demonstrated that even *partial* coating of the skin causes a variety of diseases, and especially scrofula, paralysis, consumption, and all that formidable class of afflictions arising from malnutrition and the retention of poisonous matters in the system. Such effects are not at all surprising when we call to mind the fact that the skin is capable of supplementing, to a great extent, the depurating action of the lungs, liver, and other organs, and that by its usual and direct, and also by its *vicarious* action, a greater quantity of effete and deleterious matters may be safely removed from the system than through any other channel. This being admitted, it is not strange that diaphoretics or sweating medicines should be regarded as the most valuable of all remedies, and that no class of agents is more frequently resorted to in practice. Yet no class is more unreliable; and many of these, by their depressing effects, make heavy draughts on the vital powers. How desirable, then, to have an agent that will certainly, speedily, and pleasantly excite perspiration to any desired extent, not only without exhaustion or depression, but with an increase of strength and vigor. Such an agent is the Turkish bath. As a diaphoretic it may be safely said, it *never fails.* The *light dry* air of this bath heated to a temperature of 120° to 160°, will sweat anything covered with skin permeated with vessels in which blood can circulate. But some may not be so well assured of the invigorating action of this bath. It is a popular error that perspiration is debilitating *per se,* and that none except strong persons should venture to take a Turkish bath. Perspiration in a certain class of diseases is only a symptom or result of weakness, and not a cause of it. The matters eliminated from the system by perspiration are composed almost exclusively of water and various salts and effete substances, which are not only useless but oppressive and injurious when retained, interfering with all the vital functions by poisoning and obstructing the fountains of life. It is useless then to refer to examples of the most robust health among the shampooers in Turkish baths, the operatives in foundries, the laborers in fields and workships, who perspire from morning to night. It is well known that there is no class more healthy and robust than the sweltering tribes who live in a high temperature and perspire most. I have had all classes, including the feeblest women and infants, to pass through the bath, and I have yet to see the first evidence of exhaustion or even depression from its action. It invariably imparts strength, buoyancy and vigor, both to body and mind. The tonic and invigorating effect of this bath is due, as would readily be inferred, to its depurating action, to its combination of alternate heat and cold, to its friction and shampooing, and in all probability, to its electrical effects, making all together a combination which can be had from no other bath.

As a purifier, both internal and external, nothing will compare with it. Well does Dr. Thudicum say, that "you can remove as much of the poisonous and effete matter from the body in one hour in the Turkish bath as can be removed by any other means in twenty-four hours." And he might have added that the removal of such matters, combined with the frictions and the cold water which are parts of this bath, must give a spring and vigor to the whole organism, mental and physical, which nothing else can give. The truth is, the Turkish bath will cleanse the blood as thoroughly as a sponge is cleansed by wringing it frequently out of pure water; and the principle of the cleansing is much the same. The water drank in the bath dissolves the impurities, the bath brings the water to the surface, and it is discharged with its contents. How plain! How certain!

2. It is hardly necessary to say that this bath equalizes the circulation and removes congestion. Could anything be more likely to do this than the highly rarefied dry air of this bath, followed by the friction of shampooing and the additional stimulus of the cold bath?

3. The Turkish bath not only acts on the vascular, but also on the nervous system. Under the rousing effect of the high heat, combined with friction, and followed by cold water, the nervous ramifications of the skin send revivifying, healthful currents to the nervous centers, and these, responding to the impression, return other nerve currents to the surface; thus establishing that action and reaction in the nervous system—the great motive power of the body—which is the very essence of health, strength, and vigor, and the source of those harmonious movements in all the functions, that delightful condition of mind and body, which this bath alone can bring about. Such are what might be called the indirect effects of the bath acting through the distal or peripheral nervous ramifications. Of course the direct effect on the brain and other nervous centers, from its equalizing, eliminating, and depurating action, must be very great.

4. Besides acting on the nervous system, purifying the skin and blood, equalizing the circulation, toning and invigorating the whole system, some of the advocates of this bath claim that the high heat has a direct vitalizing and electrical action; and that this heat also has the power to *destroy* the germs of disease. As to the direct vitalizing and electrical action, it is highly probable that such there is; for the electrical condition of the body and of the air must be modified by the heat, and this heat is certainly a powerful stimulant.

As to its direct action in the destruction of disease-producing germs, we cannot be so certain. Indeed, this cannot be, unless the air reaches the internal parts at the same temperature that it is externally, which cannot be true. But, admitting that no germs are destroyed by the direct action of the heat, we know that the bath has the power to expel, wash out, and eliminate from the system all disease-generating agents, unless it is living organisms; so that after all we accomplish by it the great end of all treatment—the removal of the condition on which the disease depends.

Having now given the general principles on which the Turkish bath acts, let us now apply these principles to the treatment of specific diseases. These principles can be so readily applied by all, that I need do little more than mention a few of the diseases in which experience has demonstrated the great utility of the bath. From what has been said of its equalizing action, it will be at once admitted that it is the remedy *par excellence* in all INFLAMMATORY AND CONGESTIVE AFFECTIONS, and especially those of the mucous membranes, on account of the close connection between these and the skin. Hence its superiority over any other remedy in bronchitis, in common colds, in chronic nasal catarrh, in croup, whooping cough, and in all affections of the respiratory mucous membrane. In these cases we have not only the derivative action of the bath, but also the direct action of the warm air on the parts affected—a combination that can be had from no other remedy. In other affections of mucous membranes, such as conjunctivitis, leucorrhea, diarrhea, dysentery, cystitis, otorrhea, and in short, in all inflammations of the mucous membranes, the bath will accomplish more by its derivative and equalizing action than any general or external remedy.

In CHRONIC NASAL CATARRH I believe it to be the only true curative, acting as it does by its revolutionizing effect on the whole system, and by its direct effect on the inflamed membrane; thus permanently removing the inflammation and congestion, which are generally only temporarily relieved by local applications.

I feel sure that INFLAMMATORY CROUP would be disarmed of its terrors if the sufferer could be put into a Turkish bath of a proper temperature, remaining in it till relieved, and again and again put into it on the return of the difficult breathing and other distressing symptoms. WHOOPING COUGH could doubtless be cut short or greatly mitigated in violence by this bath. The same is true of ASTHMA. In one case, I have prevented an attack several times by its use.

In PULMONARY CONSUMPTION reason and facts clearly demonstrate that no remedy is so likely to arrest its progress,

By it we may confidently expect to improve the nutritive and digestive functions, to remove internal congestions, dilate the air cells, soothe the inflamed parts, greatly increase oxygenation and decarbonization, promote expectoration, allay cough, check night sweats, procure sleep, and eliminate the tubercle-producing elements from the system. My experience, though not very extensive in this disease, has been sufficient to convince me that, even in advanced and incurable cases, nothing is so successful in relieving the distressing symptoms, and especially the debility, the cough, and the night sweats. This is also the experience of Dr. Learned, Physician to the Infirmary for Diseases of the Chest, London. He has given a detailed statement of a number of cases under his charge successfully treated by the Turkish bath. One patient, killed by accident, furnished positive evidence of the reconstruction of the diseased organs. In other diseases of the nutritive and digestive organs, this bath is entitled to more confidence than any other remedy. Its effects in DYSPEPSIA are truly wonderful, and from my own personal observation I can say that, with proper dieting and exercise, it will cure most cases of functional derangement of the stomach or bowels in a remarkably short time. The strength, appetite, digestion, and assimilation are increased almost from the first bath.

In SCROFULA and its kindred disease, CANCER, it is plainly indicated as the most promising remedy. Its power over scrofula in giving strength and vigor, in improving digestion, in promoting elimination and nutrition, cannot be doubted.

As to its effects in cancer, Dr. Thudicum says it "will remove conditions accompanying, favoring, or, perhaps, producing that awful disease." Mr. Urquhart gives a case where a removed and returning cancer, "in a desperately hopeless condition," was perfectly cured by this bath. He also tells us that cancer is unknown in countries where the bath is generally used, and where the climate is favorable to the action of the skin.

The Turkish bath is a certain, safe, and speedy remedy for OBESITY, reducing the fat, which is largely composed of water, very rapidly. This, with a dry diet, is all that is needed in this condition, which is the cause of much discomfort, and often either directly or indirectly of death.

In CHLOROSIS the Turkish bath is plainly indicated, on account of its action on the nervous system, its tonic effects, and its potent influence over the digestive, circulatory, and assimilative functions. This, with iron, nourishing diet, and exercise will be all that is required in most of these cases. In AMENORRHEA, and DYSMENORRHEA, and most of the diseases of women, I can confidently recommend the bath from my own observation of such cases.

In all cases of BLOOD POISONING, whether from drugs or disease, no remedy will compare with the Turkish bath. Of course, then, it must be an excellent remedy in SYPHILIS, by eliminating the poison from the system, and removing the effects without that injury to the system which is too often inflicted by the use of drugs. This disease in its various stages, primary and secondary, can certainly be cured, as I have proved in a number of cases. But whatever may be thought by others of the comparative virtue of drugs and the bath in syphilis, I am sure that the Turkish bath, with its *high* heat and *dry* air, will do more to eliminate syphilitic or any other poison from the system than the vapor and hot water baths of the far-famed Hot Springs of Arkansas. This will be readily understood by all who cannot fail to see the superiority of dry hot air over vapor or water as a means of exciting perspiration, and thus eliminating morbid matters from the system.

In RHEUMATISM and NEURALGIA the efficacy of the Turkish bath is admitted by all, and is too well established to require any additional testimony. It never fails to give relief in such cases, and its persevering use will cure all curable cases. In that most obstinate disease, SCIATICA, my success with the bath has been very gratifying.

In MALARIAL POISONING and in INTERMITTENT FEVERS the Turkish bath will certainly do more than any drug to eliminate the poison, equalize the circulation, arouse the action of the liver, and arrest the paroxysms. I can hardly conceive of any case of "CONGESTIVE CHILLS" that would not yield to this bath; and if anything would prevent the inhabitants of malarial regions from attacks of the pernicious fevers to which they are exposed, it would be the habitual use of the Turkish bath.

This bath also speedily removes all other poisons, such as whisky, tobacco, opium, and all drugs from the system, and to a great extent, blunts the craving for health-destroying stimulants and narcotics.

HEADACHES which are generally caused by retention of some morbid matters in the system, or by conjestion of the brain, are almost invariably relieved by the bath.

The same thing will doubtless prove true of the more formidable CEREBRAL and other disorders arising from kidney diseases. Says Dr. Von Geisen, speaking of BRIGHT'S DISEASE, "a judicious use of the bath (Turkish) robs this dreaded disease of half its terrors. The danger of uremic poisoning is placed at the remotest possible limit, and the instances in which life has been comfortably, nay, *enjoyably* prolonged, can be counted by hundreds." Dr. Hammond, of New York, speaking of cerebral congestion in general, is quoted as saying that "the Turkish bath cannot be too highly recommended."

ORGANIC DISEASE OF THE HEART has been supposed to contraindicate the use of the bath, but the observations of distinguished physicians have shown that such is not the case. It appears that in most cases the bath gives decided relief, as we might infer from its centrifugal action on the circulation, and its sedative effect on the nervous system. It certainly acts well in functional derangements of the heart, as I have witnessed in several cases.

As an anodyne, sedative, and anti-spasmodic in all forms of NERVOUS DISEASES, I regard the bath as far superior to the remedies so often resorted to unsuccessfully.

In one case of MANIA A POTU, it acted well, the patient losing sight of the "blue devils" by the time he passed through the bath, and going to sleep as soon as he came out. For SLEEPLESSNESS from other causes I have found it to be an unfailing remedy. Few cases of HYSTERIA would be likely to continue long under the use of this bath, and in CHOREA, CHOLERA, and many other nervous disorders, it is certainly one of our most promising remedies.

It has proved to be the best treatment for INSANITY. In the Cork Lunatic Asylum the cures were doubled and the deaths diminished one-half under its use. It is reported that the offensive odor of the skin of the insane is soon removed by this bath. The truth is, no personal odor can withstand a bath that thoroughly washes out a man internally and externally. I succeeded in removing the intolerable smell in a case of fœtid perspiration of the feet with a single bath, after it had continued for years in spite of all other treatment.

In many forms of DROPSY the bath is certainly our most hopeful remedy.

In PARALYSIS it is a most useful adjunct to other treatment.

Most FEVERS and many other acute diseases could doubtless be aborted by its early use.

Many other diseases in which the Turkish bath is indicated will no doubt suggest themselves to the minds of those who understand its physiological action, but I need not mention them, as my object is mainly to direct attention to the distinguishing features of the bath, and the general rather than the special principles of its action.

It would hardly be proper to close this article without saying a few words as to the use of the Turkish bath as a luxury, and as a preventive of disease. As a luxury, and as a hygienic agent, it cannot be too highly appreciated; and it should be resorted to by all who can do so, and who would enjoy health and happiness. As a beautifier of the complexion it is of special interest to ladies. It will soon bring the roses of health to the pallid cheek, and is the only true cosmetic.

For the sedentary it will answer most of the purposes of exercise; and in this respect is an invaluable boon to the thousands whose circumstances forbid their taking such exercises as are essential to health in the absence of the only substitute—the Turkish bath.

When the body and mind are depressed from anxiety, or fatigue from overwork, nothing is so soothing and refreshing as a Turkish bath.

In that condition of *mal aise*, or general depression, without obvious cause, one of these baths will generally dissipate all unpleasant feelings, and often ward off impending disease.

Such is a mere outline of what might be said of this perfection of baths, which is daily growing in popular and professional favor wherever known, and which has received the indorsement of such high medical authorities as Dr. Geo. T. Elliott, Dr. Golden, Dr. Fisher, Dr. John Armstrong, Erasmus Wilson, Spencer Wells, Sir Benj. Brodie, Drs. Borter, Wood, Doremus, Emmett, Mott, the Drs. Flint, Drs. Agnew, Hammond, Sayre, Sims, and hundreds of others, well known to physicians and people.

SALICYLIC ACID.

THIS article, the manufacture of which upon a large scale has only been rendered possible since 1874 by the patented method of Professor Kolbe, is the most important antiseptic, antizymotic, and antipyretic ever discovered. It destroys the microscopic fungi, bacteria, etc.—agents of the deleterious fermentations, of decomposition, and infection—without having any deterimental influence whatever on the animal system, and without affecting the substances treated with it for their preservation.

Salicylic acid is a white, dry, crystalline powder, devoid of smell and taste; it undergoes no change when kept in store, and it is neither inflammable nor volatile.

By means of small doses of it a considerable stock of alimentary substances and other articles liable to fermentation and decomposition can be kept in good condition for a very long time.

An individual living exclusively on a salicylated diet would not absorb so much of the salicylic acid per diem as that which is prescribed to be taken for the prevention of certain epidemics and other ailments, such as gout, rheumatism, catarrhal affections, migraine, etc.

Medical authorities agree in considering the daily consumption of one gramme as being not only perfectly inoffensive, but decidedly beneficial to health.

Salicylic acid does not accumulate in the system; on the contrary, it takes from the blood certain deleterious matters, for instance, the excess of uric acid, so productive of gout, etc., which is thus eliminated through the kidneys in the course of a few hours.

The general consumption of the salicylated soda water, containing 0·7 of a drachm per quart, is, therefore, a great means of promoting public health, especially in dangerous hot climates.

In every household, moreover, salicylic acid should always be kept ready in the following forms:

1. In glycerine and wadding for wounds.
2. In ointment for cuts and chaps.
3. For deodorizing the perspiration and preparing the feet for severe exercise.
4. In toilet powders, etc.
5. In the form of a diluted aqueous solution for gargling, and in the treatment of influenza, etc.

Solubility: The proportions in which salicylic acid dissolves, are:

One part	by weight	in	300 to 500	parts of	cold water.
"	"	"	18 to 20	"	hot "
"	"	"	50	"	glycerine.
"	"	"	3	"	absolute alcohol.

In rum, brandy, wine, cider, etc., it dissolves according to their respective strengths and temperatures.

A concentrated cold aqueous solution of the acid is made by using one quart of boiling water to every two or three teaspoonfuls of the powder, which will then rapidly dissolve; any excess crystallizes again on the solution cooling, and is available for another operation.

Alcohol mixed with water dissolves the acid in fixed proportions according to the quantity of spirit and water in the mixture; these proportions are easily ascertainable.

Note.—By contact with iron in any form, salicylic acid takes a violet color.

MEDICINE AND SURGERY.

Experiments made by the most eminent physicians and surgeons have been so successful, that both the acid and its sodium salt are universally recognized as most valuable acquisitions in medicine. The scientific papers in all countries have been full of the most favorable reports from the first authorities (mostly emanating from large hospitals) concerning the immense success obtained in using salicylic acid in surgery, gynæcology, and in treating—mostly with the salicylate of soda, all cases of gout, neuralgia, acute rheumatism, fevers of all kinds (in which it supersedes quinine), typhus, cancer, diseases of the throat and stomach, diabetes, and other intestinal complaints.

VETERINARY PRACTICE.

In veterinary practice salicylic acid has secured a recognized position as a reliable remedy in cases of milk fever, diarrhea, foot and mouth disease, strangles, and glanders. Sores arising from pressure of the saddle or harness are effectually cured by dressings of the salicylic acid ointment.

The Board of Trade of Saxe-Coburg-Gotha has published from the successful experiments of Mr. Ludloff, in Friedrichswerth (Gotha), the following process of averting pleuro-pneumonia among cattle; it speaks of salicylic acid as an infallible preventive for this fearful disease: "Dissolve two grains of salicylic acid, per head, in a pail of hot water, and add this solution to the daily drink of the cattle throughout the year."—(*Gothaisches Tageblatt*, No. 184, 1877.)

It is necessary to state that pleuro-pneumonia in the province just referred to is endemic; but it is well known how disastrous the effects of this and other diseases are to cattle, even in healthy districts. The discovery of such an excellent and absolutely efficacious remedy cannot therefore be too highly valued.

Further, there is a most striking illustration of its harmless nature in the fact, that by properly and carefully treating beehives with salicylic acid, most diseases of the bees, especially the so-called "foul-brood," are successfully prevented or cured. A slow evaporation of the acid on a tin plate, gently heated by a small flame at some distance underneath, will immediately neutralize and destroy the virus of the disease without injuring either the brood or the honey. The bees should, at the same time, be fed with salicylated honey, which serves also as a preventive.

INDUSTRIAL PURPOSES.

I.—MEAT.

Preservation for several days is obtained by rubbing the raw meat with the dry acid, or by placing it for twenty or thirty minutes in a saturated aqueous solution, and afterwards drying it. To preserve it for a longer period, *i.e.*, a fortnight, satisfactory results are obtained by the following method:

The meat is freed from fat and bones, and then cut into pieces weighing from five to ten pounds. It is next placed for ten or fifteen minutes in a saturated aqueous solution at 140° to 170° Fahrenheit, and, after cooling, packed away tightly in clean casks.

The addition of the acid at the rate of about half an ounce to the cwt., is very advantageous in salting down meat of all sorts, also for corned and sausage meat. The formation of the sausage poison, which is still of such frequent occurrence, is effectually prevented by the addition of a small quantity of the acid.

II.—MILK.

Treated with a quarter ounce of the dry acid per ten gallons, milk curdles in twelve hours only, at a temperature of 67° to 72° Fahr., and only after twenty-four hours at a temperature of 56° to 62°.

If three-quarters of an ounce to ten gallons are added, milk will only curdle after two to four days have elapsed, at a temperature of 67° to 77° Fahr., and after three to five days only at a temperature of 60° to 62°. Add the exact quantity required of salicylic acid powder to the milk, and then stir briskly for a short time, when the acid will be easily dissolved. The milk in the dairy should be kept covered with blotting paper saturated with the aqueous solution. This method is of great advantage in large farms; the milk will, in this way, allow the separation of the full quantity of sweet cream which it contains. The quantity of salicylic acid to be added depends upon:

1. The richness of the milk, and the time which has elapsed since milking.
2. The temperature of the dairy where it is kept.
3. The electric state of the atmosphere.

Special care must be taken not to use any metallic vessels, which, by the action of the salicylic acid, would slightly discolor the milk. The addition of salicylic acid will prove of especial value when milk has to be sent to any distance.

III.—BUTTER.

Salicylic acid prevents rancid or butyric fermentation, and thus butter may be preserved for a long time without the acid having any influence upon its appearance or taste.

The best methods for the preservation of fresh or sweet butter are the following:

1. Wash and knead the butter thoroughly, in wooden or earthenware vessels, in a saturated aqueous solution of the acid.

2. Add the dry acid in powder (from one to two ounces per 56 pounds) to the butter after it has been washed, and carefully knead it thoroughly in. Be particular to crush any small lumps which may be formed. If the butter is required to be kept for a long time, both methods, 1 and 2, should be combined. It is also highly recommended, when butter has been sent to a long distance, to soak the butter-cloths with an aqueous solution of the acid, and to cover it with a saturated piece of linen or white paper. The wooden tubs must also be washed with the aqueous solution of the acid.

IV.—BEER.

Experiments made upon a large scale have placed beyond a doubt the remarkable properties of salicylic acid as a preventive of "secondary fermentation" and "acidity" in beer, and as a preservative of beer in a sound condition when sent out or exposed to the noxious influences of warm cellars, change of temperature, etc. The amount of salicylic acid required to produce the best effects in preserving beer varies according to the quality of the malt liquor; but half an ounce per barrel of 36 imperial gallons will be very generally found to answer the purpose well. The addition of the salicylic acid delays secondary fermentation in stock and export beers, which may then be kept for any length of time without becoming unsound or of unpleasant flavor. Less than a quarter ounce of the powder of salicylic acid per barrel of boiling wort, strewn into the same whilst turning out, will destroy or suspend the vitality of the false ferments, especially that of the lactic ferment, in the fermenting vats, and this, not only without injury to the yeast-cells, but keeping them free from parasitical growths. In this manner the fermentation will take a steadier course and enable the liquor to attain its perfection during the ensuing still fermentation in the cask, into which another quarter ounce, or more, of the acid is to be given per barrel a fortnight before racking. Stout, and in fact all beers for export to a hot climate, require rather more.

For long transports the acid in powder can be thrown simply into the export casks, in which it dissolves in the course of three days instead of a week, which is required by the cold beer lying quietly.

BOTTLED BEER NOT SALICYLATED IN THE CASK.—The clean bottles must be rinsed with a solution of one part of salicylic acid in four or five parts of spirit (free from fusel oil), which can be poured from one bottle to another. Or, a small pinch of the acid in powder is placed in every bottle before filling.

The corks should always be boiled in water containing [illegible] ounce to the gallon, which is also efficient in disinfecting tubes, taps, etc.

Beer treated as above will always be in good condition.

maintaining its soundness and flavor to perfection, even under the most unfavorable circumstances.

V.—WINE.

With respect to wine the experiments of Professor Neubauer, of Wiesbaden (*Journal für practische Chemie*, vol. xi. and vol. xii.), have proved that the introduction of the acid for the preservation of wine marks an era of great industrial progress, as it energetically prevents, even when used in very small quantities, the formation of mould germs and other circumstances which are injurious to wine, while it absolutely arrests secondary fermentation, cloudiness, etc. As wine differs very much in its constitution, the requisite quantity of salicylic acid must be found out by practice in each particular case. About one-quarter to three-quarters of an ounce per 50 gallons will be found sufficient for most wines. In using the salicylic acid for this purpose, it is recommended to make a strong solution of it in pure spirit, perfectly free from fusel oil, and then to add of this solution as much as may be requisite.

If, in addition to this, the casks are washed out with an aqueous solution of the acid, it will prove of great service, and all other agents at present used for this purpose will soon be abandoned. The larger the amount of sugar in proportion to the alcohol, the more salicylic acid will be required. The addition is best made when the wine has attained its full ripeness. The effervescence of wine in spring, or after carriage in warm weather, will at once be stopped. The salicylic acid kills all kinds of germs, and destroys the growth and action of any yeast which may still be present; it is therefore of incalculable value in effectually preserving wine, and as a preventive of the deterioration to which this liquid is subject.

MUST, fresh from the press in autumn, can be kept without fermentation perfectly fresh, bright, and sweet for six to eight months by the addition of 1 to 1½ ounce per 50 gallons, or of ¾ ounce per 100 bottles. Sparkling must requires an addition of six to seven ounces of salicylic acid per 100 gallons. In the same manner all kinds of fruit-wine which, as is well known, soon turn sour, can be preserved by the addition of a similar quantity of salicylic acid. Must kept still for transport can at any time be set into fermentation by a slight addition of carbonate of soda and fresh yeast.

VI.—JAMS, JELLIES, PRESERVED FRUITS, FRUIT ESSENCES, ETC.

Salicylic acid is an invaluable agent for the preservation of all kinds of solutions of sugar, jams, jellies, preserved fruits, fruit juices, etc., from decomposition, fermentation, acidity, and mouldiness. As little as one-half ounce of acid will suffice for the perfect preservation of a thousand ounces, or even more, of fruit juice or pulp. To prevent loss of the acid by evaporation, it will be well not to add it to these substances until the temperature of the boiling jam, etc., has cooled down to about 170° F.

VII.—THE YOLK AND THE WHITE OF EGGS

Are most effectually preserved for a long time by the addition of half to one ounce of the acid per 20 lb. of these substances. It is also well to place a paper soaked in the salicylic acid solution on the top of them, which greatly enhances the preserving effect.

In the manufacture of vinegar, salicylic acid is also of great importance to prevent false or excessive fermentation, putridity, etc.

VIII.—GLUE, GELATINE, GUM-ARABIC SOLUTIONS, PASTE, SIZE, STARCH, INK, SKINS OF ALL KINDS, ETC.,

Are successfully preserved for a length of time from decomposition or deterioration by means of salicylic acid. One-thousandth part of the acid introduced into a vat of gelatine or into decoctions of animal matter, prevents their undergoing decomposition for an indefinite period of time. Calico printers are using half a pound of the acid to every cwt. of dressing-starch, in order entirely to preclude the disagreeable odor arising after a while from dry goods in store.

IX.—IN THE PROCESS OF TANNING,

If the bark-color be slightly salicylated, this liquor will not undergo the change which, instead of making the hides and skins swell, often causes the opposite effect, contracting them by an alkaline action, and at the same time imparting to them a putrid odor. Treatment with carbolic acid also leaves a most objectionable odor, especially in fine leather goods. The use of salicylic acid will thus be found highly remunerative to all tanners, as it has proved in the industries already alluded to.

X.—IN SUGAR FACTORIES,

Three drachms of salicylic acid are used to every 30 cwt. of beet root in the diffusing liquor, in order to prevent fermentation, and for destroying the parasitical growths, especially noticeable in the old material.

HOUSEHOLD PURPOSES.

I.—MEAT.

It is a well known fact that, especially in hot weather, meat, poultry, and game, although apparently quite fresh, prove, on closer examination, or often only when cooked, to be tainted and of bad odor. This can be entirely removed by either watering and washing the meat in a lukewarm solution of salicylic acid (three to four teaspoonfuls of acid to two quarts of water), or by adding a small pinch of the dry acid in powder, during the cooking.

To keep meat for several days from becoming high or tainted:

Place it for twenty or thirty minutes in an aqueous solution of eight drachms of salicylic acid to one gallon of water.

Rub into the surface of the meat some dry salicylic acid, particularly about the bony and fatty parts; the meat to be afterwards cleaned before cooking as usual.

Although the raw meat treated with the acid turns slightly pale on the surface, it suffers no change whatever internally. Meat thus treated with salicylic acid requires, also, less cooking to render it tender.

II.—PURE MILK.

A third of a teaspoonful (or, if the temperature be high, a little more) of the solid acid to the quart of milk delays the process of curdling for thirty-six hours, without influencing its property of yielding cream.

III.—BUTTER,

Washed with an aqueous solution (four drachms of acid to a gallon of water), or kept in it, or wrapped in cloths soaked in this water, keeps fresh for a very long time. Butter already rancid can be improved by treatment with a stronger solution (eight drachms of acid to one gallon of water), followed by washing in pure water. The bad smell often arising in salted butter is entirely prevented by addition of the acid.

IV.—JAMS OF ALL KINDS, JELLIES, PRESERVES, AND PICKLES,

Of every description, made in the usual way, but with the addition of about one drachm of salicylic acid to every four pounds of the preserve, will keep sound with absolute certainty for a much longer time, fermentation and mouldiness being prevented. Under exceptionally unfavorable circumstances, such as hot pantries, a little of the dry acid should be sprinkled on the top of the vessel or preserve pot. A tightly-fitting piece of blotting-paper, previously saturated with a concentrated solution of salicylic acid in spirit, brandy, or rum, and placed on the top of the preserves will also greatly aid in keeping them.

V. AND VI.—BEER AND WINE (*See above*).

VII.—NEW LAID EGGS

Can be kept for a very long time by being placed for half an hour in a cold, saturated aqueous solution of the acid, then allowed to dry in the air, and, as usual, kept in a cool place. (Use no straw or hay in packing eggs.)

VIII.—FOR DISINFECTING.

Fumigation with the acid purifies the air and walls of closed rooms. Simply evaporate some on a heated shovel, which must not be red hot.

The air in crowded buildings, schools, barracks, hospitals, factories, etc., will be improved by keeping the floors sprinkled with the solution. In sick rooms this is of great importance, the dust settling on the floor being the readiest receptacle and means of transmitting the microscopic fungi or germs of infection which float in the air.

IX.—VESSELS, CORKS, ETC.,

Are very well cleaned and disinfected by washing them with an aqueous solution of the acid. This deserves especial notice.

It is evident that numerous advantageous applications of salicylic acid are carried out besides those enumerated above, but the descriptions already given will enable any person interested in the matter, to find out the best means of deriving profit from the wonderful properties of this extremely useful substance.—*Monthly Magazine.*

HOW URARI IS MADE.

DR. RICHARD SCHOMBURGK, the director to the Adelaide Botanical Gardens, has just published a *brochure* in which he states what is known as to the method of preparing urari or curare, the famous deadly arrow-poison of some of the Indian tribes in British Guiana. His brother, in 1837, vainly endeavored to witness the manufacture of this poison; but Dr. Schomburgk himself, in a visit to the Canuku Mountains, near Pirara, in 3° 33' N. and 56° 16' W., succeeded in getting an old Macusi Indian to show him the method of manufacture among that tribe. The Indian, after promising to comply with Dr. Schomburgk's request, tried every possible means of evasion, but the addition of more powder and knives brought him to the scratch. The process was carried out in a small hut in the village, known as the urari-house. The Indian began first to take the bark from the strychnos, which they had brought from the Ilamikipang, and then produced the other ingredients and separated the required quantities. The native names of the other plants used are tarvieng, wakarimo, and tararemu, to all appearances species of strychnos. The Indian said they grew far away in the mountains at five days' distance. The preparation of the several ingredients would be according to weight as follows: Bark of *Strychnos toxifera*; 2 lb.; *Strychnos Schomburgkii*, ¼ lb; arimaru (*Strychnos cogens*), ¼ lb; wakarimo, ¼ lb.; root of tarvieng, ½ oz.; root of tararemu, ½ oz.; the fleshy root of muramu (*Cissus spec.*); four small pieces of wood of a tree of the species of Xanthoxyleæ, called manuca. The old Indian, having finished his preparations, went to his hut and returned with a new earthen pot, holding about seven quarts, and two smaller ones, also quite new, formed like flat pans. In the first vessel the poison was to be boiled, in the other it was to be exposed to the sun for condensation. The great strainer or funnel, made out of palm leaves, was cleaned, and fresh silk-grass was put into it to strain the fluid; a great block of wood sunk into the ground to serve as a mortar was cleaned, and in it the several ingredients were crushed. The urari preparer, after having arranged everything, built a hearth with three stones, laid the wood ready to light the fire, and went away to fetch (as Dr. Schomburgk was informed, for he had not exchanged a single word with the old Indian) the utensils to light the fire, though there was a large fire burning which was of no use, having been lighted by profane hands. Neither dared the Indian use any water except that brought in the pot to be used for the operation; in fact, no other implement could be used but such as had been made by the cook, neither would he have assistance from any of the inhabitants. Any transgression of the sacred rules would nullify the operation of the poison. In addition to the fleshy root of the muramu, he crushed the several kinds of bark, but each one singly, on the mortar, lighted the carefully piled-up wood, and then threw first into the pot, which was filled with water, the bark of the *Strychnos toxifera*. As soon as the water began to boil the Indian added at certain intervals a handful of the other ingredients, except the muramu root. In doing so he bent his head over the pot, strongly blowing into the mixture, which he said afterwards added considerably to the strength of the poison. During the process he only kept as much fire as was necessary for slow boiling, carefully skimming the foam collecting on the extract. Within the next twenty-four hours the old man left the fire only for one moment, keeping the mixture at an equal heat. After the lapse of twenty-four hours the extract became thick, and was reduced by the boiling to about a quart, the color being that of strong coffee. The old cook then took the extract from the fire and poured it into the strainer, the extract trickling slowly into another flat vessel, and left the remainder in the silk-grass. After exposing the strained extract to the sun for about three hours, he added the slimy juice pressed out of the root of the muramu, which had previously been soaked for a short time in the boiling poison, and then had been pressed out. The poison immediately exhibited a remarkable alteration, curling to a jelly-like substance. After this peculiar process he poured the poison into earthen vessels, flatter than those before mentioned, for the purpose of bringing the poison to a consistence equal to that of thick treacle by exposing it to the sun. Afterwards it was poured into the peculiar small calabashes, or half-round earthern vessels, manufactured only for that purpose, where it ultimately changed to a hard substance. On the third day the poison was ready, when the cook, satisfied with the product, tried the strength of the poison on some lizards in Dr. Schomburgk's presence. He dipped the point of a pin into the poison, let it dry, wounded one of the lizards in one of the toes of the hind foot, and then let it run. In nine minutes the peculiar symptoms of the poison made their appearance, and one minute after the slightly wounded animal was dead. A rat died in four minutes, and a fowl in three.

The Indians declare the poison loses its effect after two years, but its power can be destroyed by pouring some manihot juice upon it. Dr. Schomburgk took some of the urari to Berlin with him, and made several experiments with it, when he found that it frequently took from fifteen to twenty minutes, according to the tenacity of life, before death ensued. A commission of scientific men was appointed by the German Government to report on the effects of the poison, and many experiments were made, from the frog to the horse. Professor Heintz made a careful analysis of the poison, and, though it was made from strychnos, he found it contained no strychnine. From experiments made by Professors Virchow and Münter they conclude: 1. That the urari kept dry will, after the lapse of five years, retain its intense and rapid efficiency. 2. That it has no effects like those of strychnine. 3. That it is not a tetanic poison, but operates by stupefying. 4. That urari causes palsy, produces a discontinuance of the voluntary movements of the muscles, with continual functions of the involuntary muscles of the heart, intestines, etc. 5. That the external application of urari is not fatal, but only when absorbed through a wound. 6. That death is not the direct result of poisoning, but of the discontinuance of the mechanical action of respiration. Urari, Dr. Schomburgk states, has been successfully used both in tetanus and hydrophobia.—*London Times.*

A HOMELY SUBSTITUTE FOR COD-LIVER OIL.

DR. THOMAS ADDIS EMMET ("Principles and Practice of Gynæcology") recommends as a good substitute for cod-liver oil the fat of pork. For its proper preparation he gives directions as follows: A thick portion of a rib piece, free from lean, is selected and allowed to soak in water for thirty-six hours before being boiled, the water being frequently changed, to get rid of the salt. It should be boiled slowly and thoroughly cooked, and, while boiling, the water must be changed several times by pouring it off, and fresh water, nearly boiling, substituted. It is to be eaten cold, in the form of a sandwich, made from stale bread, and both should be cut as thin as possible. It is very nutritious, but it should only be given in small quantities until a taste for it has been acquired. It is the most concentrated form in which food can be taken in the same bulk, and Dr. Emmet has frequently seen it retained when the stomach was so irritable that other substances would be rejected. For this condition of the stomach, it may be rubbed up thoroughly in a porcelain mortar, and then given in minute quantities at a time. It is made more palatable by the addition of a little table-salt, and this will be well tolerated, while the salt used for preserving the meat, having become rancid, if not soaked out, will produce disturbance, even in a healthy stomach.—*British Medical Journal.*

SUBSTITUTE FOR CASTOR OIL.

DR. OGILVIE WILL, of Aberdeen, has made some observations on the *Rhamnus frangula*, or black alder. He recommends a fluid extract made from the bark, each fluid drachm of which contains an equivalent of one drachm of the bark. The extract is a dark brown, thick fluid, with a sweet and agreeable taste. The dose varies from one to two drachms for a child. As an aperient it has many advantages over *Rhamnus catharticus*. It causes no nausea, no eructations, and no griping. The stools are not in general loose, and never watery; it usually acts only once. It seems to have in addition tonic and aromatic qualities, by which the muscular action of the bowels is slightly stimulated. It is particularly serviceable in children, in those suffering from hemorrhoids or other affections of the rectum, after surgical operations about the pelvis or abdomen; in inflammatory or spasmodic diseases of the genito-urinary organs; in pregnant and puerperal women; and generally in all circumstances in which it is desirable to move the bowels gently without occasioning local irritation or general disturbance, and as it has not constipating after effects, it forms an efficient and safe substitute for castor oil as a laxative.

THE MEDICAL USES OF MILK.

M. BIOT, in the *Revue Mensuelle de Médecine et de Chirurgie*, 1879, gives a summary of the clinical facts observed at the Hotel Dieu at Lyons, on this subject. The deductions and conclusions drawn by M. Biot touching the nature of acute articular rheumatism and the efficacy of the milk regimen in the course of this affection, are based on a number of analyses of urine, made as completely as possible, since they give the amount of the total nitrogen, of the urates, of the total chlorides, and of the phosphoric and sulphuric acids. His theoretical and therapeutical views on the subject are thus summarized: The fever of acute rheumatism generally lasts two or three weeks, and consequently, either from the time it lasts or on account of the high rise in temperature, causes an enormous consumption of blood corpuscles, which produces profound anæmia in the patient. The fall of temperature is the best criterion of the cure, and coincides exactly and constantly with the disappearance of the pains. The tortures endured by patients suffering from acute articular rheumatism are in themselves alone of a violence and tenacity sufficient to induce the physician to endeavor to oppose to this disease a treatment which would unite the three qualities, *citò, tutò, et jucundè.* The milk diet seems capable of fulfilling this desideratum; it causes the temperature to fall rapidly below hyperpyrexia, and simultaneously assuages the pains in a period varying from three to eight days. The effects from these two points of view are more prompt and more powerful if the patient be submitted to the milk regimen at the outset of the affection. This milk regimen, without overcharging the stomach or raising the temperature, by its nutritive power and its facility of digestion, prevents, in great measure, that characteristic and generally troublesome anæmia left behind by attacks of rheumatism. Besides these general effects, milk diet has a special action on the urinary function, which is clearly indicated in rheumatism. Milk strongly favors the elimination of all the waste principles accumulated in the organism; its exclusive use causes both the quantity of urine excreted in twenty-four hours and the quantity of all the saline principles dissolved in this liquid to increase rapidly; density, on the contrary,

experiences a proportionate decrease. The impetus given to the urinary function by a milk regimen allows a glimpse of the nature of rheumatism, its near and intimate causes. The analyses of urine seem to show that there is an accumulation of urates or uric acid in the organism of rheumatic sufferers, and that its diminution under the influence of milk is not one of the smallest benefits of this regimen.

TREATMENT OF PHTHISIS BY INHALATIONS OF BENZOATE OF SODA.

PROF. ROKITANSKY is disposed to think very highly of this treatment, although he is as yet unprepared to publish the results of his observations. He thinks that the method in which the inhalations are practiced is of great importance, and that they should, therefore, be always taken under the supervision of the physician. In order that the spray may find free access to the throat and lungs, he directs the patient to draw the tongue forward or to hold it down with a spatula, and then to take deep inspirations until coughing is excited. The inhalations are repeated until the cough is no longer followed by expectoration. He assumes that the tubes are then cleared of mucus, and that the medicine comes into direct contact with the mucous membrane. The inhalations are practiced morning and evening, and the patient is kept for an hour afterward in the room, the air of which has become more or less impregnated with the benzoate of soda. As Buchholz and Klebs have shown that this drug destroys bacteria with certainty only when administered in the proportion of $\frac{1}{1000}$ of the weight of the body, Rokitansky makes his patients inhale daily one gramme of the drug (in a five per cent. solution) for every $2\frac{1}{4}$ lb. of their weight. He attributes to this medication, first of all, a destructive action on bacteria ; and, secondly, a mechanical action on the pathological secretions, which are rendered more liquid and are more readily removed from the air-passages. This results in an amelioration of the catarrhal symptoms, and perhaps prevents the transformation of the secretions into caseous masses. Further, he believes that the forced inspirations and expirations dilate the air-vesicles and counteract the compression of the vesicles by interalveolar tubercular masses. He is convinced, moreover, that the benzoate of soda, when used in this manner for a long time, acts also as a febrifuge. Of course, he combines with the inhalations the usual hygienic and dietetic treatment.

Dr. Schnitzler, of Vienna, on the other hand, is inclined to be skeptical with regard to the value of these inhalations. For the sake of experiment, he made a large number of patients inhale a five per cent. solution of benzoate of soda, which had been colored with a few drops of aniline, or alternately solutions of tannin and perchloride of iron, and, on examining them afterward with the laryngoscope, found the mouth and pharynx uniformly discolored by the solutions, while the larynx and trachea presented only a few isolated discolored spots. From this he argues that atomized liquids do not penetrate to any extent into the bronchi, and that the marvelous effects attributed to the benzoate of soda, if not entirely illusive, must be ascribed to the volatilization by heat of the benzoic acid, which can then undoubtedly penetrate into the smallest tubes. Hence, he claims that it would be more logical to employ directly the volatile benzoic acid for the inhalations, and that if any special curative action be expected from the benzoate of soda, it would be preferable to administer it internally, when the same results could be obtained with much smaller doses. He closes his paper by recommending, as an antiparasitic treatment of phthisis, the inhalation and subcutaneous injection of carbolic acid, a treatment which he has employed for three years with relatively very favorable results.—*Annales de la Société Médico-chir. de Liége.*

THE DRAINAGE AND SEWERAGE OF CITIES.*

By COL. GEO. E. WARING, C.E., of Newport, R. I.

THE president has asked me to prepare a paper concerning the most perfect methods of city sewerage, one which may serve as a standard of comparison in considering the character of existing work. It would savor of presumption to describe or to prescribe methods radically different and better than those now in use. It is impossible to foretell the improvements which are to grow out of the present rapidly increasing interest among intelligent and ingenious men in all that relates to sanitary practice. If I were to attempt now to set forth the details of a perfect system of sewerage I fear that my recommendations, like Dr. Richardson's City Hygeia, would surpass what practical men and investors of capital would accept.

The most that it is prudent to do is to consider the question in its purely sanitary bearings, and to indicate in what way the best requirements of public health may be met in the light of our present knowledge.

So far as we can judge of the future from the indications of the present, it would seem that, in one respect, we are to witness a very marked change in the practice of sanitary engineering. There is much reason for believing that there will be a distinct separation between the application of sewerage to the removal of domestic and manufacturing wastes and soil water and the construction of conduits for the protection of public and private property against the action of storm water. This latter, like the construction of roadways and bridges, will be treated as a purely civil engineering question, having, at best, only an indirect sanitary relation. The interests of public health, so far as sewerage is concerned, will, in my opinion, be best served by a close adherence to the collection and removal of foul waters, and to their proper final disposal.

This suggestion is not new. The discussion between the advocates of the combined and the separate systems of sewerage, especially in England, has long been active. The issue between them seemed doubtful until the matter of agricultural or chemical purification of the effluent became prominent.

The arguments in favor of the exclusion of storm water from the sewers proper seem to me so conclusive that I no longer hesitate to accept such separation as essential to the best sanitary sewerage.

Sewers large enough to remove storm water, according to the usual formulas, are open to several serious objections.

The question of cost is so often the controlling question, even in improvements of the most vital importance, that the expense entailed by the construction of storm-water sewers constitutes an insuperable obstacle in the case of many a small town where sewerage is most necessary. Even in the larger cities the expenditure in this direction might sometimes, if not always, be economized for the benefit of other necessary work.

The larger the sewer the more difficult becomes the matter of ventilation.

Cases are extremely rare where sewers of the storm-water size are not, at least during the dry and hot season, sewers of deposit to such an extent as to have their air made most foul by the decomposition of their sediment.

Where the question of final disposal has become important, the admixture of storm water with the sewage leads to the constant embarrassment of the system, whether the process be chemical or agricultural.

There seems to be no controlling reason why storm water should be admitted to the sewers at all for very long reaches of the street; and not seldom, throughout the whole of the smaller towns, the whole rain-fall may be discharged over the surface without causing inconvenience.

Until about 1854 the cities of Albany and Troy, both large towns, and both having very steep grades terminating on level ground, had no storm-water sewers. The inconvenience caused during heavy storms was inconsiderable, and there was practically no material injury to public or private property. I am informed by the engineer of both cities that neither inconvenience from the overflowing of the streets nor injury from wash constituted an essential argument in favor of the sewerage. The sewers were built to the storm-water rise only, in conformity with the general custom.

The carrying of surface water to the depth of 10 or 15 feet below the surface seems to be at least unnecessary. Street wash can be safely admitted to sewers only after passing through settling basins, which are sure to accumulate an offensive and dangerous amount of decomposing filth.

I believe that one of the most important improvements that we are destined to see is the removal of storm water, as far as possible, by surface gutters—carrying away the greater accumulations through very shallow conduits, largely, perhaps, through covered gutters, easily accessible for cleaning and flushing.

This part of the engineering problem being satisfactorily provided for, the sanitary drainage of a town—the removal of the wastes of its population—becomes a simple problem. It implies, however, one condition which, although almost unknown in America, has been shown by foreign practice to be an attainable one—that is, that it requires that the streets be kept clean by some other means than occasional drenching by storms. There is no more inefficient, costly, and dangerous scavenger than the rain which falls upon the surface of our roadways and washes their horse-droppings into the catch-basins at the street corners.

In my judgment a perfect system of sanitary sewerage, for a small town or a large one, would be somewhat like the following:

No sewer should be used of a smaller diameter than six inches, because (*a*) it will not be safe to adopt a smaller size than 4-inch for house drains, and the sewer must be large enough surely to remove whatever may be delivered by these; (*b*) because a smaller pipe than 6-inch would be less readily ventilated than is desirable; (*c*) and because it is not necessary to adopt a smaller radius than three inches to secure a cleansing of the channel by reasonably copious flushing.

No sewer should be more than six inches in diameter until it and its branches shall have accumulated a sufficient flow at the hour of greatest use to fill this size half full; because the use of a larger size would be wasteful, and because, when a sufficient ventilating capacity is secured, as it is in the use of a 6-inch pipe, the ventilation becomes less complete as the size increases, leaving a larger volume of contained air to be moved by the friction of the current, or by extraneous influences, or to be acted upon by changes of temperature and of volume of flow within the sewer.

The size should be increased gradually, and only so rapidly as is made necessary by the filling of the sewer half full at the hour of greatest flow.

Every point of the sewer should, by the use of gaskets or otherwise, be protected against the least intrusion of cement, which, in spite of the greatest care, creates a roughness which is liable to accumulate obstructions.

The upper end of each branch sewer should be provided with a Field's flush tank of sufficient capacity to secure the thorough daily cleaning of so much of the conduit as from its limited flow is liable to deposit solid matter by the way.

There should be sufficient manholes, covered by open grating, to admit air for ventilation. If the directions already given are adhered to, manholes will not be necessary for cleansing. The use of the flush tank will be a safeguard against deposit. With the system of ventilation about to be described, it would suffice to place the manholes at intervals of not less than 1,000 feet.

For the complete ventilation of the sewers it should be made compulsory for every householder to make his connection without a trap, and to continue his soil-pipe to a point above the roof of his house. That is, every house connection should furnish an uninterrupted ventilating channel four inches in diameter throughout its entire length. This is directly the reverse of the system of connection that should be adopted in the case of storm-water and street-wash sewers. These are foul, and the volume of their contained air is too great to be thoroughly ventilated by such appliances. Their atmosphere contains too much of the impure gases to make it prudent to discharge it through house-drains and soil-pipes. With the system of small pipes now described, the flushing would be so constant and so complete, and the amount of ventilation furnished, as compared with the volume of air to be charged, would be so great that what is popularly known as sewer-gas would never exist in any part of the public drains. Even the gases produced in the traps and pipes of the house itself would be amply rectified, diluted, and removed by the constant movement of air through the latter.

All house connections with the sewers should be through inlets pointing in the direction of the flow, and these inlets should be funnel-shaped, so that their flow may be delivered at the bottom of the sewer, and so that they may withdraw the air from its crown—that is, the vertical diameter of the inlet at its point of junction should be the same as the diameter of the sewer.

All changes of direction should be on gradual curves, and as a matter of course, the fall from the head of each branch to the outlet should be continuous. Changes of grade within this limit, if considerable, should always be gradual.

So far as circumstances will allow, the drains should be brought together, and they should finally discharge through one or two main outlets.

The outlet, if water-locked, should have ample means for the admission of fresh air. If open, its mouth should be protected against the direct action of the wind.

It will be seen that the system of sewerage here described is radically different from the usual practice. I believe that it is, in all essential particulars, much better adapted to the plan of sanitary drainage. It is cleaner, much more completely ventilated, and is exactly adapted to the work to be performed. It obviates the filthy accumulation of street manure in catch-basins and sewers, and it discharges all that is delivered to it at the point of ultimate outlet outside the town before decomposition can even begin. If the discharge is of domestic sewage only, its solid matter will be consumed by fishes if it is delivered into a water-course, and its dissolved material will be taken up by aquatic vegetation.

The limited quantity and the uniform volume of the sewage, together with the absence of dilution by rainfall, will make its disposal by agricultural or chemical processes easy and reliable.

The cost of construction, as compared with that of the most restricted storm-water sewers, will be so small as to bring the improvement within the reach of the smaller communities.

In other words, while the system is, in my judgment, the best for large cities, it is the only one that can be afforded in the case of small towns.

Circumstances are occasionally such, as in St. Louis, as to require extensive engineering works for the removal of storm water through very deep channels. Ordinarily, as I have before said, the removal of storm water is a very simple matter, if we will accept the fact that it is best removed, so far as possible, by surface gutters; or, in certain cases, by special conduits placed near the surface.

It is often necessary, in addition to the removal of house waste, to provide for the drainage of the subsoil. This should not be effected by open joints in the sewers, because the same opening that admits soil water may, in dry seasons and in porous soils, permit the escape of sewerage matters into the ground, which is always objectionable. Soil-water drains may be laid in the same trench with the sewers, but preferably on a shelf at a higher level, and they should always deliver into the upper part of the sewer, or into a manhole at a point above the flow-line of the sewerage.

There is one point connected with the drainage of towns which is not sufficiently appreciated, especially in this country; that is, that it is easy and cheap to secure a deep outlet in lowland, and to deliver sewerage at a considerable elevation for agricultural treatment by artificial pumping.

The average cost of pumping for water-works is about 9 cents per foot of elevation for each million gallons raised.

On this basis the cost of raising the sewage of a town of 10,000 inhabitants, supposing every three persons of the population to contribute 100 gallons per day to the flow, would be about 3 cents per day for each foot of elevation.

Even supposing that 20 inches, or about one-half of the annual rainfall, finds its way into the subsoil, the cost of lifting this 10 feet to a surface outlet would, on the same basis, cost only about $160 per annum for each 100 acres of the town area.

Both of these estimates are practically somewhat too low, because a small amount of water cannot be lifted relatively so cheaply as a large amount. I give these figures only to show that, with a community of any considerable size, it is really a matter of minor consequence whether the natural outfall is high or low.

The experience of Holland, in the practice of drainage, indicates a complete relief for the natural disadvantages even of the city of New Orleans, of which the cost would be quite insignificant, as compared with its benefits.

Many of our riparian towns, dependent upon high-lying water as the outlet for their drainage, or, like Chicago and Milwaukee, delivering their foul drainage into streams whose contamination means the contamination of the town itself, may find their only practical relief by means of an artificial outlet. The City of Boston is now establishing a conspicuous example of the application of mechanical power to deep drainage and distant removal, even applying this costly means for the discharge of the rainfall of an enormous area.

Aside from its benefit in securing deep drainage, discharge by pumping makes us quite independent of natural topography in adopting means for agricultural disposal. Pumping, and the separate removal of foul wastes, puts it in our power, under all circumstances, to adopt this means for purifying our outflow. Along our greatest rivers, from the sanitary standpoint, the disposal question counts for nothing. The Mississippi River will annihilate the sewage of St. Louis to whatever size she may grow; but there is an enormous proportion of our towns which must, for purely sanitary reasons, adopt some other means of outlet than delivery into rivers and harbors.

There is an agricultural consideration, and an important one, which looks to the utilization of all our sewage, but in the present condition of our agriculture this must remain a secondary argument. Wherever we resort to irrigation as a means of purification, the manurial value of the sewage will serve to lessen the cost of our work. Probably it will nowhere pay the whole cost.

The methods of irrigation disposal are various, and all are not equally well adapted to all conditions. The outflow of a large town can be purified satisfactorily, either by simple irrigation over large areas, or by intermittent downward filtration over much smaller areas of land properly graded and deeply underdrained. Under this system the discharge is intermittent, and during the intervals the soil-filter is purified by atmospheric action.

The outflow of smaller towns, of public institutions and of suburbs and country houses, may be much the most satisfactorily treated by the absorption drain or sub-surface irrigation system, working in conjunction with Field's flush tank. By this system a small area of land, naturally or artificially well-drained, is underlaid at a depth of ten inches from the surface, by a series of open-jointed, agricultural drain tiles. At each discharge of the flush tank, the accumulated sewage is sent rapidly into the tiles, whence it escapes through the open joints into the soil. During the interval between the discharges, the water, purified by filtration, settles away to the subsoil, and fresh air enters to supplement, by oxidation, the purifying action of the roots of the grass or other crop growing on the land.

This latter system has now been so thoroughly tested under various conditions as to climate and quality of soil, as to have proved itself of almost universal applicability. It has the very great advantage that, as the sewage never appears at the surface of the ground, it may be carried on in immediate proximity to the dwelling. It would be equally effective, under proper arrangement, in dealing with the sewage of cities; but for such use it would be much more costly than would the removal of the sewage to a distant field, where surface irrigation would be unobjectionable.

I trust that, as I am neither a southerner nor a physician, I may be excused for attaching more importance than many

* Read at the recent meeting at Nashville, Tenn., of the Amer. Public Health Association.

of you probably do to the proper drainage and cleansing of a city, and to the proper disposal of its outflow, than to any system of quarantine. My knowledge of the history of the yellow fever epidemics in this valley is infinitely less than yours; but I feel warranted, and I take my warrant from the history of the plagues which devastated the filthy medieval cities of Europe, and from my own knowledge of the want of cleanliness and want of drainage in the city of Memphis, in venturing the suggestion that even that fever-smitten town may be made an impossible field for the invasion of yellow fever in an epidemic form.

While yellow fever is for the moment uppermost in all our minds, and while its sudden and more fatal outbreaks strike the public imagination with peculiar force, we should, as sanitarians, never lose sight of the fact that it is one of our minor diseases; that, indeed, along the banks of the Mississippi river far greater mortality and infinitely greater disability result from the constant operation of diseases which should come equally within our purview, and which are equally preventable by measures of sanitary improvement.

VARNISHES FOR PROTECTING IRON.

I THINK it will simplify their description if they are divided into three classes. A varnish is usually a compound of two or more substances, mixed in such proportions that the whole has a suitable consistency. When applied and exposed to atmospheric influences, a hard and uniform skin is formed. The covering thus produced may be the result of the evaporation of the volatile components, the basis having been originally dissolved by the spirituous component. For instance, if India-rubber (caoutchouc) be dissolved in bisulphide of carbon, and the liquid applied as a varnish, the volatile component readily evaporates on exposure to air, leaving a uniform coating of hard India-rubber. Atmospheric oxygen contributes nothing to the result. Such a varnish illustrates those comprised in the first class.

If ordinary or boiled linseed oil be applied as a varnish, the whole eventually forms a hard coating, but the result obtained in this instance is due to the formation of a solid oxidation product, in which atmospheric oxygen plays a necessary and important part. Linseed oil is, therefore, an example of the second class varnishes.

In the practical application of varnishes of ordinary composition both these processes co-operate. The volatile or spirituous component of the varnish evaporates, while another component of the varnish undergoes oxidation, producing a solid substance which is incorporated with the solid substance of the original varnish. The media employed for grinding up metallic oxides, in order to prepare a paint, behave in this way. They, therefore, may be taken as examples of the third class.

The most useful and interesting example of the first class is coal tar. Its method of production is too familiar to my readers to require any description. We may consider it as pitch dissolved and suspended in other substances which can be dissipated at moderate artificial temperatures. Pitch almost entirely consists of hydrocarbon compounds, the amount of oxidized resinous material present being small and of a very stable character—a fact one is prepared for when the high temperature to which the pitch has been subjected is considered. A hydrocarbon compound is wholly composed of carbon and hydrogen. Naphthaline ($C_{10}H_8$) is a familiar example. The hydrocarbon compounds in pitch and coal tar are, speaking generally, of a very stable type. They are practically unaffected by atmospheric oxygen and the presence of water at ordinary temperatures. Some, such as the paraffins, are of an exceptionally permanent character, requiring the strongest chemical agencies to bring about the formation of new substances. The paraffins are known in the gaseous, liquid, and solid state; but those having the first of these three characters are absent in coal tar, and therefore in pitch. There is comparatively nothing known by chemists respecting the individual components of pitch. Many of the more volatile constituents of coal tar are thoroughly well understood. I need but mention naphthaline ($C_{10}H_8$), anthracene ($C_{14}H_{10}$), benzene (C_6H_6), and carbolic acid (C_6H_6O), to show the character and importance of some of these. And the character of the components of pitch, whatever they may be, is but of a more permanent order than that of many of the substances just named. When coal tar is used as a preservative of iron gasholders, it should be employed in a hot state. The reason for this is twofold. Firstly, the tar more thoroughly permeates the interstices of the wrought iron; and, secondly, the volatile constituents of the tar are more readily got rid of, leaving an even surface of pitch. This, as a varnish, has many excellent qualities. It resists the action of atmospheric oxygen and the gases found in a gasworks. It is also proof against the influence of moisture, since it is incapable of forming hydrated compounds when immersed in water. But it has one great defect—it tends to flow like a liquid. It is a matter of common observation that when a lump of pitch is placed on a level surface, it slowly extends itself, unless adequately supported by lateral pressure. The substance is what the physicist terms "viscous." The weight of its own particles causes them to slide slowly over each other, under the circumstances, and take up new positions. This tendency to assume the fluid character is augmented by increase of temperature. Hence, when an iron gasholder has been coated with tar, and the operation is in other respects successful, the pitch gradually tends to "run," and form elongated drops or streams, presenting an appearance "which, to the eye of the anxious gas manager, is disgusting." The removal of the pitch from its original position exposes the iron at points to the usual corroding influences. This important defect which pitch possesses places coal tar at a great disadvantage, especially in a hot climate. At home it forms a most efficient varnish, particularly for submerged ironwork, provided it be properly applied. Coal tar, therefore, is the type of a durable and in some respects efficient varnish. Were we able to prepare a form of pitch devoid of the viscous character, but having the other attributes of ordinary pitch, we should then have realized our ideal of what the basis of a varnish should be. I am not aware that any special attempts have been made to render pitch more useful. Natural forms have been used for purposes such as we are now considering, and it is just possible that some of these may have less of the fluid character than artificial pitch. When dissolved in the more volatile components of coal tar, the natural kinds furnish compounds analogous in many respects to the latter.

The defect which pitch as a basis for a preservative varnish presents is in a great measure avoided by the employment of caoutchouc. This substance is obtained from the milky juice which exudes from the lacerated stems of several tropical trees and arboraceous plants. In the natural state (ordinary India-rubber) it is a mixture of at least two hydrocarbons containing the same relative proportions of carbon and hydrogen. It is also noteworthy that these proportions are the same as obtain in rectified oil of turpentine ($C_{10}H_{16}$). Caoutchouc is not viscous, and therefore can be employed in high atmospheric temperatures. It also forms a hard, continuous surface when in spirituous solution and applied to iron surfaces as a varnish. But it has imperfections of such a character that, when employed alone as a basis for a preservative varnish, the result is a coating inferior to that formed by coal tar in its general use. This coating is prone to be affected by natural influences in a curious way. For instance, *in the dark*, atmospheric oxygen and water exert comparatively little influence on it, but in daylight it is very seriously altered by these agents. Oxidation and hydration products are formed, rendering the surface of the caoutchouc glutinous. Hence, disregarding the question of cost, caoutchouc, as a basis for a preservative varnish, is lower in the scale of general efficiency than pitch.

It is particularly interesting to know that Mallet's experiments and writings of 1839–41 demonstrated that, though caoutchouc varnish might be used with advantage in special cases, coal tar heated and applied to the iron in a hot condition was at that time the most efficient preservative of wrought-iron plates when the latter had to be exposed to air and saline solutions in a warm climate. His views were strongly in favor of the use of a mixture of naphthaline, paraffin, and asphaltum (pitch) in combination with mineral peroxides—that is, the highest of the oxides, not of an acid character, furnished by the combination of the metal and oxygen. Clearly his idea was to use hydrocarbons of such a character and in such proportions that the mixture would need some additional substance as body. He regarded the mineral peroxides most favorably, since the metal present has already combined with as much oxygen as it possibly can under all ordinary circumstances, and therefore cannot be further affected by atmospheric oxygen. The hydrocarbons he mentions are some of those I have named, and are characterized by great stability. In principle the suggestions are excellent, but I fear that, if carried out in the way they are given, the defect of coal tar, so proverbially well known, would not be obviated. Suppose ferric oxide to be used in combination with coal tar, the whole being applied to the iron in a hot condition. Would the resulting pitch be devoid of a viscous nature? Not unless a relatively large quantity of the oxide were used, which in practice would be found objectionable. —*W. Foster, in Journal of Gas Lighting.*

ON THE DETECTION OF ORGANIC MATTER IN WATER.

By F. TIEMANN and C. PREUSSE.

THE authors premise the statement that, according to prevailing opinion, putrescent organic matter is the most suitable medium for the development of disease ferments which may be distributed by air and water as well as by animals. While the foreign mineral matter in water is easy to detect and to determine, the recognition of organic impurities and still more their quantitative estimation is attended with the greatest difficulties. Among these the bodies formed by fermentation from the albuminoids, the fats, and the carbohydrates deserve particular attention. Among the products of the albuminoids the following have been recognized: Peptons, amido-derivatives of mono and bibasic acids of the fatty series (leucin, asparagic acid, glutamic acid, etc.), acids of the fatty series (valerianic, butyric, etc.), trimethylamin, and the following compounds belonging to the aromatic series: Phenol, cresol, indol, scatol, tyrosin, hydro-para-cumaric acid, etc. The fats are split up into glycerin and fatty acids rich in carbon, which are afterward or simultaneously transformed by oxidation into acids of lower groups. From the carbo-hydrates there are formed by fermentation a number of alcohols (aldehyds) and acids of the fatty series. Waters in connection with cesspools may further contain the constituents of urine and their products of decomposition. Where the residues of vegetation are decaying, substances of the humus class, poor in nitrogen, will also be present. Hence the organic impurities of water may differ almost infinitely in their properties. Fixed and volatile bodies, permanent and unstable compounds, may occur together. Hence there cannot exist any simple method for determining the total amount of the organic matters in water. The following methods have been hitherto employed:

I.—DETERMINATION OF ORGANIC MATTER BY THE IGNITION OF THE RESIDUE LEFT ON EVAPORATION AT A FIXED TEMPERATURE.

The residues obtained after evaporation at 80° have been ignited with access of air, and the caustic lime thus produced reconverted into carbonate by means of ammonic carbonate, the final loss of weight being taken as organic matter.

The authors remark that fixed organic substances may be partially decomposed during evaporation; that the mineral substances present may at 180° retain variable proportions of water; that silicic acid may expel carbonic acid which is not restored by treatment with ammonic carbonate; and that small quantities of organic chlorides may be volatilized, while the organic matter may react upon nitrates and nitrites. Hence the result stands in no direct proportion to the fixed organic matter originally present in the water.

II.—METHOD OF FRANKLAND AND ARMSTRONG.

For the description of this process and of the apparatus the reader is referred to Sutton's "Volumetric Analysis" (second edition, p. 250).

In this method its authors do not take into account the organic substances present in water and volatile in acid solutions. Nor do they regard the decompositions which the fixed organic compounds may undergo during the evaporation of the water under the influence of sulphurous acid and of the ferrous chloride generated. As the percentage of carbon and nitrogen in various organic compounds varies, the numbers found give no clew to the absolute quantity of fixed organic matter present in the water examined, and the results of a comparative examination of different waters by this method will be comparable only when the mixture of organic matter present in each case is alike in its nature. The method shows, however, whether nitrogenous matter, not volatile from acid solutions, is present.

III.—METHOD OF DITTMAR AND ROBINSON.

For a full description of the process the reader is referred to the *Chemical News* (vol. xxxvi., p. 26).

The authors consider that it can be executed more rapidly and with somewhat simpler appliances, but that it is open to the same objections. It is an approximation to the methods of F. Schulze and F. Bellamy.*

IV.—DETERMINATION OF ORGANIC MATTER BY MEANS OF PERMANGANATE.

The authors describe the modifications proposed by Kubel, Schulze, and Tidy. The first of these, which they consider preferable, consists in acidulating with dilute sulphuric acid and boiling for ten minutes with an excess of centinormal permanganate. The residue of the latter is decomposed by a centinormal solution of oxalic acid and the excess of the latter titrated with permanganate. From the total quantity of the latter the proportion which has served for the oxidation of the oxalic acid is deducted, the remainder showing the permanganate decomposed by the organic matter of the water.

These methods take into account the volatile organic matter as well as that of a fixed nature. The different organic compounds, however, contain very different proportions of carbon, hydrogen, and nitrogen, and therefore consume very various quantities of oxygen. The authors consider that Tidy's process is "provided with a series of sources of error."

V.—FLECK'S METHOD.

In place of permanganate the authors used a solution of silver nitrate in hyposulphite of soda mixed with caustic soda. The standard solutions required in this process are very liable to change, and the final reaction is easily overstepped as in all "spotting" processes.

Further, the silver solution is directly inferior to permanganate as a reagent for organic matter.

In connection with the examination of the permanganate processes, the authors have found by direct experiment that volatile organic substances are to be found in waters, and they even recommend that special attention be paid to contaminations of this nature. Kubel's process, they admit, gives no especial clew to the presence or absence of nitrogenous matter, a problem which, to a certain degree, they regard as solved by the remaining process.

VI.—METHOD OF WANKLYN, CHAPMAN, AND SMITH.

The authors describe briefly this method, omitting the addition of carbonate of soda for the first distillation, and remark that the process is simple and easy, and gives, when the instructions of its inventors are closely adhered to, comparable results. Small portions of volatile organic matter may, they consider, escape prior to the addition of the alkaline permanganate. It is also not very easy to obtain this solution free from ammonia. The transformation of organic nitrogen into ammonia is most complete in the decomposition products of the albuminoids. Just as was shown to be the case with the methods of Frankland and Kubel, this process shows the comparative quantities of nitrogenous matter in different waters only when similar mixtures of organic compounds are present.

In summing up, the authors consider it more probable that disease ferments are present in a polluted than in a pure water, though it must not be inferred that every impure water must necessarily prove pernicious. When it becomes pernicious, neither the physician nor the chemist can decide, though both may point out when it should be avoided as suspicious.—*Berichteder Deutschen Chemischen Gesellschaft.*—*Chemical News.*

ROSIN AND FATS IN CEMENTS AND LUBRICANTS.

ACCORDING to the *Pharm. Central-Halle*, the sample under examination is heated upon the water bath, with a sufficient quantity of soda lye and spirit of wine, until it is thoroughly saponified. The spirit is then evaporated off, the residue dissolved in cold water, and decomposed with muriatic acid. On heating in the water bath, the fatty matter, together with the rosin, collect together. When cold, the liquid is poured off, and the fatty mass is first washed with cold water, then covered with several times its own bulk of water, and heated to 122° to 140° F., and gradually mixed with small portions of bicarbonate of soda. By this means the fatty matter is again converted into a soap which dissolves in the water, whilst the rosin remains suspended in the liquid or attached to the sides of the vessel, and may be easily separated from the other ingredients by filtration. The fatty acids are determined in the usual manner in the solution of the soap.

PRINTING ON WOOLEN.

THE following processes are intended for machine work on woolen yarns:

Black.

Extract of logwood	3,000 parts.
Boiling water	6,000 parts.

Dissolve, cool, and add to the clear liquid:

Black liquor at 5° B.	500 parts.
Nitrate of iron at 50° B.	125 "

Thicken with

Gum tragacanth	250 "

The quantity of gum may of course be modified as requisite.

Print, air for six hours, and steam at 212° F. for three-quarters of an hour, and rinse.

Brown.

Extract of sapan	1,000 parts.
Extract of bark	500 "
Water	6,000 "

Dissolve at a boil, and thicken the clear liquid with

Gum tragacanth	125 parts.

Add

Red liquor at 5° B.	220 "

To sadden the brown add a little black liquor.

Print, air, steam, and rinse.

Bismarck Brown.

Bismarck brown	30 parts.
(More or less according to shade.)	
Water	6,000 "

Dissolve at a boil, cool, and thicken with

Gum tragacanth	80 parts.
Starch	80 "
Strong glue	40 "

Print, air for six hours, steam at 194° F., and rinse.—*Teinturier Pratique.*

* Zeit. Anal. Chem., viii., 394 and 398.

ULTRAMARINE.

By C. FURSTENAN.

THE present position of the ultramarine manufacture, and the certainty with which this color is prepared, render it possible to lay down standard prices.

In these estimates the following points must be taken into consideration. In recent works I use the waste steam of the machine:

1. For warming the feed water.
2. For heating the water for lixiviation.
3. For warming the packing and other workshops.
4. For yielding distilled water, free from grease, in sufficient quantity for elutriation and wet-grinding.

The process is thus rendered independent of the quality of the water in the neighborhood. For drying the ultramarine I use the waste heat of the furnaces. No outlay is, therefore, incurred for all the above purposes. As I stated, as far back as 1864, there are three qualities of ultramarine.

I. A soda ultramarine, rich in silica and in sulphur; of a violet blue color, and containing alum.

II. A soda ultramarine, poorer in silica and sulphur, and of a pure blue.

III. A Glauber's salt ultramarine, containing the same silicate as II., but much less sulphur; of a greenish blue, and chiefly used for ultramarine green.

These qualities will be referred to as I., II., and III.

A.—*Raw Materials.*

The figures are the averages of the mixings. For 2 cwt. of finished ultramarine are required:

	I. Lb.	II. Lb.	III. Lb.
China clay	122	183	178¼
Soda	122	183	—
Sulphur	122	72½	—
Glauber's salt	—	—	213½
Sand	22	—	—
Reducing agents	22	17½	35¼

B.—*Fuel.*

The calculation is made for lignite (brown coal).

(1) Lignite necessary for manufacturing 2 cwt. ultramarine:

I. Lb.	II. Lb.	III. Lb.
347	671	849

Of Zwickau coal the average consumption for II. and III. was 440 lbs.

(2) Supposing that a 12-horse power engine suffices for the yearly production of 60 tons, then for each 2 cwts of ultramarine 374 lb. of lignite will be required for steam.

C.—*Labor.*

Two cwt. will require the labor of the following persons for the subjoined fractions of a day's work of 12 hours:

	I.	II. & III.
Engineer	0·300	0·300
Grinder	0·300	0·300
Sifter	0·262	0·262
Stoker	0·786	1·310
Laborers	2·358	2·358
Packers	1·048	1·048

The prices for labor quoted are of no value to the English reader, as the grinder, who is most highly paid, receives only three shillings for a day's work of twelve hours.

The total cost for the manufacture of 2 cwt. ultramarine is:

I. 44s. 6d.
II. 42s. 2½d.
III. 32s. 5¾d.

The average sale price for 2 cwt. is £4 5s.; lowest price, £2 2s. 6d.; highest price for calico-printers' purposes, £7 13s.; for lithographers', £11 18s.

It is of course very doubtful in how far the price of labor in England would affect this manufacture. Supposing it double the figures here quoted the respective cost prices of the three qualities would be:

I. 54s. 6d.
II. 52s. 2½d.
III. 42s. 5¾d.

There would be in some districts of England a small advantage in the price of fuel, but as the fuel does not reach 12 per cent. of the total working expenses, the gain under this head would be very far from compensating for the increased cost of labor. We may, therefore, conclude that the manufacture of ultramarine would be decidedly less advantageous in England than in Austria, Germany, etc., possibly one reason why it has not taken root more extensively among us.—*Chemiker Zeitung.*

LACTATE OF FERROUS OXIDE DEVELOPER.

IN writing to the *Photographisches Wochenblatt* on the development of gelatine plates, Dr. J. Schnauss says, with regard to the keeping qualities of the ferrous oxalate developer that so far as he can see, frequent boiling up of the solution not only is of no assistance but really accelerates the decomposition, iron hydroxide being thrown out, and the solution becoming a dirty greenish-brown. When filtered and evaporated almost to crystallization and left to cool, beautiful emerald-green crystals of the double salt of ferric oxalate and potassic oxalate are obtained (that is to say, that in spite of their green color they only contain iron as an oxide).

He, therefore, tried a variety of ways of making an iron oxalate bath, which had become decomposed, usable again For example: he conducted sulphureted hydrogen gas through it until all the Fe_2O_3 was converted into FeO, then boiled it to drive off the excess of sulphureted hydrogen, and now filtered off the pricipitated sulphur. A little ferrous oxalate was mixed with the latter, and the solution only retained some of the suboxide for a short time. Thus the Fe_2O_3 cannot be precipitated from the decomposed iron bath in the usual way by an alkali, as oxalic acid as well as tartaric acid prevents the precipitation. If, however, potassic acetate be added in excess and then caustic potash, and the whole be boiled, most of the ferric oxide will be thrown down as hydroxide. After filtration the alkaline fluid can be neutralized with oxalic acid, and by evaporation a mixture of acetic acid and neutral oxalate of potassium, with a small quantity of undecomposed ferric oxalate, will be obtained. This procedure is, however, very troublesome, and the potassic acetate is always a new source of expenditure. The restoration of the worn-out iron oxalate bath still remains but a pious wish, for it is too expensive a bath to be needlessly thrown away, and it is greatly to be desired that a cheaper developer could be found for these plates.

Dr. Schnauss then experimented with other iron salts and organic acids, for which Mr. M. Carey Lea's interesting experiments furnished him with ample materials. In searching for a better iron developer than that with ferrous oxalate Dr. Schnauss was not very fortunate, though he made a great number of experiments. It seemed to him that in the case with which the iron oxalate double salts can be oxidized their great developing power, which far exceeds that of the other iron salts, should be sought. Oxalic acid by itself has no action; but, for example, formiate of iron suboxide ought to possess stronger developing properties, which is not the case, although, as is well known, this acid reduces the silver salt much more rapidly. He experimented successively with citric acid, succinic acid, formic acid, and lactic acid without obtaining the hoped-for result.

Fortunately, however, he found that *lactate of ferrous oxide* would be a very good developer for *wet collodion plates.* A rather strong solution of it in water is prepared for developing purposes, to which only the usual quantities of glacial acetic acid and alcohol are added. The development proceeds very rapidly and equally, and the negatives are very delicate in the half-tones, as is usually the case when an organic acid is present instead of sulphuric acid in the iron developer. Here is a basis on which to build up a very pretty 500-franc secret rapid process!

In conclusion: Dr. Schnauss mentions that his lactate of iron developer for wet plates is very inexpensive, as he only paid about two shillings and fourpence for a kilogramme of it, and that it may be bought at any chemist's under the designation of "*ferrum lacticum.*" A hot concentrated solution should be prepared first, filtered, and used when cold after addition of the proper quantities of acetic acid and alcohol.

INJURY TO VEGETATION BY ACID GASES.

THE poisonous action of coal smoke and the fumes of metallurgical and chemical works upon vegetation depend almost exclusively upon the effects of acid gases, especially the sulphurous and the hydrochloric, the former of which is by far the more pernicious. Hence the combustion products of coal and lignite are the more pernicious the more sulphur is present. Wood smoke has no action upon vegetation. The leaves of trees exposed to sulphurous acid turn brown over their entire surface, while hydrochloric acid appears to attack principally the edges. Annual crops resist better than trees. Broad-leaved trees may be thus arranged in the order of their sensitiveness: red beech, birch, lime, poplar, alder, ash, plane, and oak. [The walnut tree is more sensitive than any of the above-mentioned, and from observations in Lancashire we should give the oak a different place.]—*Chem. News.*

NEW APPLICATION OF METHYL-CHLORIDE.—C. Vincent applies methyl-chloride, previously liquefied and purified by passage through concentrated sulphuric acid, for the purpose of extracting perfumes from flowers.

PROPERTIES OF THE GUM OF THE EUPHORBIACEÆ.

CERTAIN euphorbiaceous plants growing in Natal yield a gummy matter, which, if dissolved in alcohol and applied to metallic objects, preserves them from the corrosive action of the sea or of brackish waters. It also secures articles of wood, etc., from the ravages of the white ants.

PHOSPHORESCENT POWDERS.

THE patentees of this process (Prince Sagan, W. F. McCarthy, and E. Peiffer) employ a mixture of 100 parts carbonate and phosphate of calcium (obtained by the ignition of shells, especially *Tridana* and *Sepia*) with 100 parts of quicklime, 25 parts of calcined salt, and 25 to 50 per cent. of whole mass of sulphur; 6 to 7 per cent. of a coloring matter—a sulphide of calcium, strontium, barium, magnesium, aluminum, etc.—must then be added. This powder serves to render barometers, compasses, etc., luminous, and is particularly phosphorescent under the influence of an electric current.

OLIGISTE FROM THE LAVA OF VESUVIUS.—The author steeped fragments of lava in a concentrated solution of common salt, placed them in a bottomless crucible, and heated them over a Bunsen burner. After a few days of constant heating the pieces of lava became covered with hæmatite, whilst laminæ of oligiste were sparingly scattered over their surface.

COLORING MATTER OF CUCUMIS ANGURIA AND OF THE TOMATO.—The coloring matter in question, rubidin, is extracted from the fruits by means of ether, which dissolves it along with a yellow coloring matter. The ether is evaporated away and the residue treated with anhydrous alcohol, in which the yellow compound dissolves, whilst rubidin is left undissolved in the form of small crystals.—*Antonio and Giovanni de Negri.*

DETERMINATION OF THE PROPORTION OF WATER IN ALCOHOL.—The author utilizes a property of the alcoholic solution of the sulphocyanide of cobalt, which is changed from a blue to a red color on the addition of water. By adding a few drops of the blue solution to a mixture of equal volumes of water and of alcohol, of sp. gr. 0·830 (=87·7 per cent.), the liquid is at once turned red. This change of color is also produced by a mixture of 60 vols. alcohol and 40 vols. water, but if 80 vols. of the alcohol are added to 20 of water the liquid remains blue. The author believes that this method may be developed so as to give approximate results.—*Aug. Vogel, in Bayerisch. Indust. und Gewerb. Bl.*

QUANTITATIVE DETERMINATION OF FATS AND RESINS IN CEMENTS AND LUBRICANTS.—The mixture is heated upon the water bath with a sufficient quantity of soda lye and alcohol until thoroughly saponified. The alcohol is expelled by heat, the residue taken up in water, and decomposed with hydrochloric acid. When heated on the water bath the fatty acids which have been liberated and the resins collect together, and after cooling may be separated from the liquid, washed with cold water, covered with several vols. of water, and heated to 50° or 60° with the gradual addition of sodic bicarbonate in small portions. A soap is thus formed from the fatty acids and dissolves, while the resin floats in the liquid or is deposited on the sides of the vessel, and may be separated by filtration. The fatty acids in the solution of soap are determined in the usual manner.—*Pharm. Central Halle.*

THE SOAKING OF WOOLEN CLOTH.

OUR valued contemporary, *Das Deutsche Wollengewerbe*, has lately discussed the effect of hot water upon woolen cloth, showing that much misconception on this subject exists among German manufacturers, and as we have reason to suppose that the knowledge of English manufacturers concerning this matter is not always quite clear, we think some remarks may not be devoid of interest.

Woolen cloth is generally cropped when dry, and raised when damp, and why? The reason for this is found in one of the properties of wool. The substance of hair of sheep greatly resembles that of the horns of beasts, viz., it gets brittle in a dry warm atmosphere, and soft in the presence of dampness and a moderate heat. As an instance of this, the comb-makers boil their slabs of horn and then put them upon heated plates, when their cutters go through them as easily as through a leather strap, while they polish them to a glassy finish by friction when dry and cold. Wool, like horn, swells and is elastic when moderately warmed and damp, and brittle and hard when cold or exposed to a dry heat. These qualities, taken in conjunction with external pressure, act very importantly in producing felting, for here the softened hairs are pressed against each other, and remain so through the interlacing of their ridges. In milling, or more properly in the locking, this cohesion is produced in an irregular manner, but in pressing, the fibers assume a more straightened direction, which produces the gloss.

Consequently, when the cloth is to be cropped, the cloth should be dry, so that the fibers stand better out, and on account of their greater brittleness can be better clipped, which would be more difficult if the fibers were soft. The object of raising is to loosen the fibers on the surface of the cloth, which through the operation of fulling have been more or less felted, and this for the reasons mentioned can be easier done when the fibers are soft than when they are brittle and adhering to one another. The cloth is, therefore, before being raised, placed for a few hours in moderately warm soft water, but care must be taken that this is not too hot, so that the hair gets only soft and is not through excessive heat felted, which would impede the operation of raising; its felting is facilitated by pressure, and the weight of the cloth upon itself must also be taken into consideration. It will be found that at a heat of 130° to 140° Fah. is the safest, though occasionally 150° may not be unsafe, and that with this temperature the cloth ought to be soaked from six to ten hours. If, however, it is desired to shorten this time, and by a mistaken notion, as a compensation, the heat is raised to say 170° Fah., it will have the effect of felting the surface of the cloth, which, as before stated, gives more trouble in raising, though it produces a gloss on the surface; and if the heat be still greater, it may felt the cloth in its interior, and make the raising a still more difficult operation. Another inconvenience will arise in so far as the lower layers of the cloth will felt in the folds, which then are almost impossible to remove by any subsequent operation.—*Textile Manufacturer.*

GELATINE EMULSION FOR AMATEURS.

THE difficulties of prolonged cooking deterred me for a considerable period from attempting the manufacture of gelatine emulsion, and there was little in the slower form of plate to attract one from the simplicity of collodio-bromide. I had, therefore, determined that I would *not* try the gelatine process. After a while, however, came the simplification of cooking with a portion of the gelatine at a high temperature for a short time. My resolution gave way and I tried it, and liked it so much that I here propose to detail my present method of working. The apology I make for occupying the columns of the *Journal* with it is that the process involves the most humble apparatus, and the expenditure of the least amount of the amateur's time.

To Make the Emulsion.—Provide a six-ounce medicine bottle with *flat* sides, a one-pound coffee canister, and a small saucepan of about a quart capacity. Provide (say) one ounce of Nelson's No. 1 photographic gelatine. I may remark, by the way, that the length of the "threads" of this gelatine makes it awkward to weigh up; therefore, take a pair of strong scissors and cut it up to shorter lengths, until it is found more manageable. Set five grains of this to soak while you go on with the rest. Weigh thirty grains of potassium bromide and put it into the bottle, pour upon it half an ounce of cold water, place the bottle in the coffee tin, and pour in some cold water to reach a little over one-third up the bottle, which does not require corking. Place this in the saucepan with cold water, somewhat corresponding to the height of the water in the tin. While that is heating over the fire dissolve forty grains of silver nitrate in half an ounce of water. By this time the five grains of gelatine will be swelled up, and may be drained and transferred to the bottle containing the potassium bromide. While this is dissolving set thirty-five grains of gelatine to soak in water.

Let us suppose that the water in the bottle is quite hot. Remove the saucepan, coffee can, and bottle to the dark room, and fit a cork to the bottle. Pour in the solution of silver nitrate, a little at a time, with shaking between. Rinse out the vessel which held the silver with a small quantity of water, and add it to the emulsion. It must now be taken back to the fire; but before leaving the dark room take the cork out of the bottle and put the cover on the coffee canister to exclude all light.

Set the apparatus on a slow fire, and after the water in the outer vessel has boiled remove the whole of it back again to the hob, but with the side of the saucepan so exposed to the fire that the water shall be kept simmering. If very sensitive plates are wanted it may be kept here for half an hour, but for the first trial, say, a quarter of an hour. If the deposit be examined on a bit of glass it will be found to have changed from ruby to gray.

Remove again to the dark room and add the rest of the gelatine, free from superfluous water. Keep it in the hot water until thoroughly dissolved; then take the bottle out, insert the cork, and lay it flat on its side to set. If the weather be hot a drop of carbolic acid may be added. Cover the bottle to exclude light, and, supposing this to be done in the evening, let it stay till next one. Don't hurry.

To Wash the Emulsion.—Next evening take a jug or similar vessel holding two or three pints. Tie a piece of linen or similar material loosely over it, and make a hole in the middle of it to admit the neck of the bottle. Fill the jug and the bottle containing the emulsion with water, place the finger as a temporary stopper to the bottle, and invert the latter in the hole in the cloth covering the jug.

The cloth, it will be seen, becomes a support for the bottle, the neck of which is downward. Other contrivances may suggest themselves, but the principle is to have plenty

of water into which the soluble salts may gravitate as fast as they leave the thin layer of gelatine in the bottle.

Cover the bottle with the coffee can and leave it in the dark room until next evening, when the water in the bottle and jug must be changed and set aside till next evening, then again to be repeated. I have found these three long-continued washings sufficient, but not having tried less, cannot say if it would be effectual. Although it seems a long time, I think it saves the time of the amateur, who has simply to change the water. It, moreover, preserves every drop of emulsion, and is not "messy," nor does the gelatine take up much more water. The emulsion may now be warmed to 90°, and made up to two ounces if short of that, including half a drachm of alcohol.

To Coat the Plates.—Provide a small invalid feeding cup, having a spout. Make a small bag of fine old flannel, double, and fit to a ring of silver wire. Put this inside the cup so as to leave an opening as wide as possible. Pour the emulsion from the bottle into the bag and through the spout into the bottle. Repeat this a time or two. Now proceed to coat the plates. Pour on the emulsion through the spout, and tip the superfluity into the flannel bag in the cup. By this plan the emulsion is kept free from clots. The plate must not be drained, but just quickly tipped and restored to the horizontal position. The emulsion may be guided to cover the plate with the finger or a bit of clean paper, and must look evenly creamy before it is laid down to set.

I dry my plates in a darkened room, and have nothing special to recommend, either in this respect or in development. In development I should, however, recommend the amateur who is not acquainted with the alkaline method to employ the freshly-mixed solutions of sulphate of iron and oxalate of potash, as I find this develops with great brilliancy and clearness—no stain, and clean glass for deep shadows.

I have found no frilling, and am inclined to think this is generally due to the glass not being clean enough. I have found it in some of the best plates in the market, but, of course, could not verify my ideas. I should even expect to find less frilling in an emulsion that does not set very quickly.

It may not be generally known that a gelatine emulsion plate may be used in the camera as soon as properly set, and will stand the developing, fixing, and intensification quite as well, or better than a dry one.

My lamp is glazed with ruby glass, having a piece of crimson tissue paper secured to it by means of ordinary negative spirit varnish. The source of light is a benzoline lamp. —*W. D. Richmond, in British Journal of Photography.*

PREPARING GELATINE PLATES.

By JOHN MATTHEWS.

THE process of preparing gelatino-bromide plates which I found the easiest and most simple is the following (it is, indeed, the only one in which my efforts have been crowned with success). However, that speaks more for my want of skill than any defect in the other processes, for many good men and true have apparently succeeded with them; but as my failures would interest few people, I give the one I believe I have mastered—at any rate, the one which produces me good results. The following is the formula I employ:

Nelson's No. 1 photo. gelatine	10	grammes.
Ammonium bromide (pure)	8	"
Water (distilled)	280	"

I put these into a large bottle, and in a short time the gelatine becomes swollen, and the bottle is put into a warm water bath, and there agitated until its contents are dissolved. This I sensitize by adding to it:

Nitrate of silver	12	grammes.
Distilled water	50	"

When this is dissolved I pour it with the other, a little at a time, shaking it up well. When all the silver solution has been added, pour into it 1 drachm 25 minims of pure ammonia, and shake the solution up again. The ammonia renders it quicker in its sensitizing, and prevents it decomposing. After the above has been done I pour the solution of gelatine into a porcelain dish, and place it in my sink in the dark room to set. When it has set I detach it from the dish and place it between one or two thicknesses of muslin, and wring it so that the gelatine is expelled in shreds, which I easily wash through a fine sieve of muslin. A washing of five hours in water three times changed I find is sufficient. I then collect the pellicle on a clean linen cloth, and dissolve it at a temperature of 95° Fahr. It is then ready to coat the plates with.

This is the formula that was given by Dr. Van Monckhoven to the Belgian Photographic Association, and since its publication it has been my favorite process. I have rarely failed with it, and when I have, it has been through carelessness in not correctly following the directions. All my operations of mixing the various preparations I do in my dark room I am then perfectly sure that I am on the safe side, whatever occurs. From mixing the gelatine with the bromide, to conveying the solution after "cooking" into another apartment to coat the plates, it is never out of the dark room. The only time that I had the gelatine decompose was on an occasion when I had omitted the ammonia. This adding of ammonia undoubtedly has an effect in rendering the emulsion more sensitive. I never cook it more than three or four days, sometimes not so much, and I find it gives me pictures exceedingly quick, equal to some of the most rapid commercial plates. I am very fond of this formula, and think it is just the thing for an amateur. When it has done "cooking" I convey it, well covered up in an earthenware coffee-pot, to the room where I coat the plates. I have a large negative box full of these, well dusted and slightly warmed, on a long deal counter which I had made for the purpose. I stand the plates on one end of the table, and at the other end I place a rather tall lens cupboard, which I have had fitted up with shelves between these two; with a spirit-level, I level a large sheet of plate glass, by the side of which I place a glass rod. Now I am ready. I carefully note that every little crevice is carefully stopped up to exclude the light, and I light my lamp (this lamp has only a front glass to show the light, I having carefully gone over the other side with Bates's black varnish); the front I first stained with ordinary negative varnish, considerably impregnated with iodine, and then with a very good sort of orange varnish a painter forgot to take away from my house after decorating operations. In front of this lamp, also, to make sure, I place a piece of ruby glass, and I turn on very little gas. My plates are just warm, and I pour on the emulsion, aided with my glass rod, without the slightest difficulty. As I do them I place them on my leveled plate glass, which holds fourteen half plates. In a very few minutes they are set, and I place them on the shelves in my cupboard, which are lined with common filter paper. This prevents them sticking to the shelves from the cause of a little going over the back, which was the case in two instances, I having only got them away in pieces with the aid of a chisel and hammer. After I have placed them in the cupboard, I cover it up with two large tablecloths, and for twelve hours, in dry weather, I keep a gas stove lighted up in one corner of the room; longer in damp weather. I very seldom find that these plates want intensifying; this I attribute to my using plenty of pyro in the development. On those rare occasions when they do require it, I dip them in a small glass dish containing a solution of the following:

Bichloride of mercury	80	grains.
Iodide of potassium	100	"
Water	3	ounces.

Sometimes just dipping them in this for a few moments will be sufficient, but I very rarely want to intensify them; I always avoid it if possible, and with proper care in the development I believe it can be avoided.

ANILINE FUMING FOR DURABLE GELATINE PAPER.

DURABLE gelatine paper is of itself almost as insensitive as washed silver paper. It is, however, like the latter, rendered sufficiently sensitive by fuming with ammonia, and, like the latter also, the amides act even more beneficially upon it. Thus quite a surprising result is obtained by fuming with ethylamide. By employing ethylamide the deep shadows do not acquire a metallic luster; in the case of pictures which unroll ethylamide does not produce a yellow band as fuming with ammonia often does; and, lastly, ethylamide furnishes very delicate and, at the same time, extremely brilliant impressions. The high price of the amides, however, stands greatly in the way of their chance of being employed by the professional photographer.

My experiments with the amides led me, as is self-evident, to the use of aniline, which is also related to ammonia. In the aniline ($C_6H_5NH_2$) one atom of hydrogen is replaced by an atom of phenyl (C_6H_5). The fuming with aniline vapor at first appeared to me to offer no advantage whatever, as the prints from my average negatives appeared flat and weak. But, on covering the negative with several folds of silk paper, a very excellent result was obtained, although the printing process was necessarily very protracted. During the present dull weather I again resumed the aniline fuming in the expectation that it would be useful when long printing was otherwise rendered necessary by the weather, and I was not disappointed. Negatives from which, in consequence of the slowness with which the printing proceeded, I had only been able to get very hard prints, furnished when aniline fuming was employed perfectly harmonious, fully-printed pictures.

Simply silvered paper (not bathed in a gelatine solution) is not suited for aniline fuming, as such paper would be saturated by a greasiness caused by the aniline fumes, and, at the same time, it may be remarked that aniline fuming requires a little previous arrangement, and, therefore, it should only be used for exceptional cases.

The fuming of the gelatine paper I undertake when in the printing-frame and during the exposure, and for that purpose I use a sheet of blotting-paper well but not too thoroughly saturated with aniline. For that purpose I sprinkle a sheet of blotting-paper with aniline oil, rub it equally over the sheet of paper, and then place the latter between six sheets of clean blotting-paper. These seven sheets I then put between a pair of boards, and place a few stones, as a weight, upon the uppermost board. In the course of the night the whole six sheets are saturated with the aniline. I lay one of them upon the pressure-back of the printing-frame which is to be used, and cover it with two correspondingly large pieces of tracing cloth. The printing-frame is then ready for the plate to be placed in it. The covering over of the blotting-paper with tracing cloth should not be neglected, as it is intended to prevent the direct fuming of the gelatine paper, or of the varnish film of the negative, by the blotting-paper saturated with aniline.

So far the matter is pretty simple, except that aniline is in certain circumstances a very dangerous substance and requires to be handled with the greatest precaution. In spite of its volatility aniline adheres for days to the paper which has been impregnated with it, and in that condition the latter produces a fatal yellow spot wherever it is laid down. Further: aniline has the property of dissolving almost all resins with great ease. The negatives, which are nowadays almost all coated with resinous solutions, must, therefore, be carefully protected from the direct action of the aniline. Lastly, when recklessly used aniline may act injuriously upon the health of the user, for aniline is numbered among the poisons. Therefore, beware! Take care!—*Fritz Haugk, in Photographisches Wochenblatt.*

ON THE SECULAR CHANGES IN THE ELEMENTS OF THE ORBIT OF A SATELLITE REVOLVING ABOUT A PLANET DISTORTED BY TIDES.*

THE investigation which forms the subject of this paper is entirely mathematical, and is therefore not of a kind to be easily condensed into a short account.

This paper is the fifth of a series (of which notices have from time to time appeared in *Nature*) in which I have endeavored to trace the various effects on the configuration of a planet and satellite, which must result from tidal friction —the tides in the planet being either a bodily distortion or oceanic. The investigations are, I think, not without interest as a branch of pure dynamics; but this side of the subject is too complicated to be made intelligible without mathematical notation, and it would occupy too much space to explain the methods of treatment.

There is, however, another side of the subject which must, I think, attract notice, or, at least, criticism, and this is the applicability of the results of analysis to the history of the earth and of the other planets.

We know that no solids are either perfectly rigid or perfectly elastic, and that no fluids are devoid of internal friction, and therefore the tides raised in any planet, whether consisting of oceanic tides or of a bodily distortion of the planet, must be subject to friction. From this it follows that the dynamical investigation must be applicable to some extent to actual planets and satellites. For myself, I believe that it gives the clew to the history of the system, but of course an ample field for criticism is here opened.

The investigation is intended to be more especially applicable to the case of the earth and moon; and, therefore, instead of planet and satellite, the expressions earth and moon are used.

The effect of tidal friction upon the eccentricity and inclination of the lunar orbit here affords the principal topic. The obliquity of the ecliptic, the diurnal rotation of the earth, and the moon's periodic time were considered in a paper read before the Royal Society, on December 19, 1878, and which will appear in the *Philosophical Transactions* for 1879.

The present paper completes (as far as I now see) the main investigation for the case of the earth and moon, and therefore it is now possible to bring the various results to a focus.

It appears then that, when we trace backward in time the changes induced in the system of the earth and moon by tidal friction, we are led to an initial state which is defined as follows:

The earth and moon are found to be initially nearly in contact; the moon always opposite the same face of the earth, or moving very slowly relatively to the earth's surface—the whole system rotating, in from two to four hours, about an axis inclined to the normal to the ecliptic at an angle of 11° 45', or somewhat less; and the moon moving in a circular orbit, the plane of which is nearly coincident with the earth's equator.

This initial configuration suggests that the moon was produced by the rupture, in consequence of rapid rotation or other causes, of a primeval planet whose mass was made up of the present earth and moon. The coincidence is noted in the paper, that the shortest period of revolution of a fluid mass of the same mean density as the earth, which is consistent with an ellipsoidal form of equilibrium, is two hours twenty-four minutes; and that if the moon were to revolve about the earth with this periodic time, the surfaces of the two bodies would be almost in contact with one another.

The rupture of the primeval planet into two parts is a matter of speculation, but if a planet and satellite be given in the initial configuration above described, then a system bearing a close resemblance to our own would necessarily be evolved under the influence of tidal friction.

The theory postulates that there is not sufficient diffused matter to materially resist the motions of the moon and earth through space. Sufficient lapse of time is also required. In a previous paper I showed that the minimum time in which the system could have degraded from the initial state, just after the rupture into two bodies, down to the present state, is fifty-four million years. The time actually occupied by the changes would certainly be much longer.

It appears to me that a theory reposing on a *vera causa*, which brings into quantitative correlation the lengths of the present day and month, the obliquity of the ecliptic, and the inclination and eccentricity of the lunar orbit, must have considerable claims to acceptance.

It was stated that the periodic times of revolution and rotation of the moon and earth might be traced back to a common period of from two to four hours. In a previous paper the common period was found to be a little over five hours in length; but that result was avowedly based on a partial neglect of the sun's attraction. In this paper certain further considerations are adduced which show that, while the general principle remains intact, yet the common period of revolution of the earth and moon must initially have been shorter than five hours to an amount which is uncertain, but is probably large. The period of from two to four hours is here assigned, because it is mechanically impossible for the moon to revolve about the earth in less than two hours, and it is uncertain how the rupture of the primeval planet took place.

But if tidal friction has been the agent by which the earth and moon have been brought into their present configuration, then similar changes must have been going on in the other bodies which make up the solar system. I will, therefore, make a few remarks on the other satellites and planets.

In the first place, it is in strict accordance with the theory that the moon should always present the same face toward the earth. Helmholtz was, I believe, the first who suggested tidal friction as the cause of the reduction of the moon's axial rotation to identity with her orbital motion. It is interesting to note in this connection that the telescope seems to show that the satellites of Jupiter, and one at least of the satellites of Saturn, also have the same peculiarity.

The process by which tidal friction brings about the changes in the configuration of a planet and satellite is a destruction of energy (or rather its partial conversion into heat within the planet, and partial redistribution), and a transference of angular momentum from that of planetary rotation to that of orbital revolution of the two bodies about their common center of inertia.

Now a large planet has both more energy of rotation and more angular momentum; hence it is to be expected that large planets should proceed in their changes more slowly than small ones.

Mars is the smallest of the planets, which are attended by satellites, and it is here alone that we find a satellite revolving faster than the planet rotates. This will also be the ultimate fate of our moon, because after the joint lunar and solar tidal friction has reduced the earth's rotation to an identity with the moon's orbital motion, the solar tidal friction will continue to reduce it still further, so that the earth will rotate faster than the moon revolves.

Before, however, this can take place with us, the moon must recede to an enormous distance from the earth, and the earth must rotate in forty or fifty days instead of in twenty-four hours. But the satellites of Mars are so small that they would only recede a very short way from the planet before the solar tidal friction reduced the planet's rotation below the satellite's revolution. The rapid revolution of the inner satellite of Mars may then, in a sense, be considered as a memorial of the primitive rotation of the planet round its axis.

The planets Jupiter and Saturn are very much larger than the earth; and here we find the planets rotating with great speed, and the satellites revolving with short periodic times. The inclinations of the orbits of Jupiter's satellites to their "proper planes" are very interesting from the point of view of the present theory.

The Saturnian system is much more complex than that of Jupiter, and it seems partially in an early stage of development and partially far advanced.

The details of the motions of the satellites are scarcely well enough known to afford strong arguments either for or against the theory.

I have not as yet investigated the case of a planet or star attended by several satellites, but perhaps future investigations may throw further light both on the case of Saturn and on the whole solar system itself.

The celebrated nebular hypothesis of Laplace and Kant

* An account of a paper by G. H. Darwin, F.R.S., lately read before the Royal Society.—*Nature.*

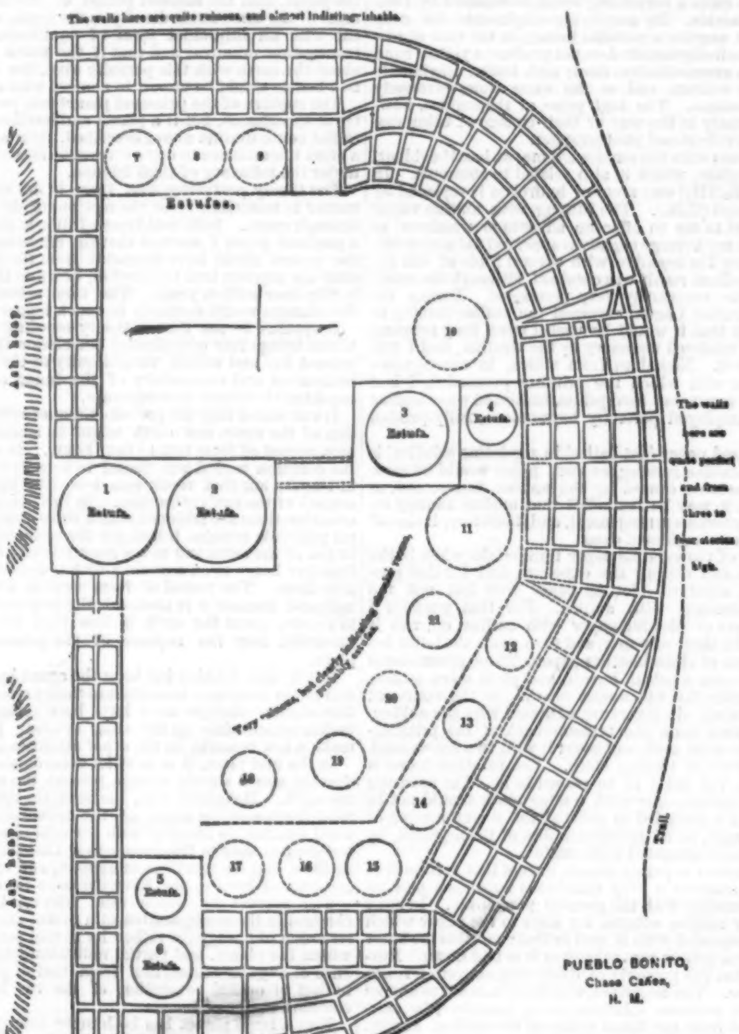
supposes that a revolving nebula detached a ring which ultimately became consolidated into a planet or satellite, and that the central portion of the nebula continued to contract, and formed the nucleus of the sun or planet. The theory now proposed is a considerable modification of this view, for it supposes that the rupture of the central body did not take place until it was partially consolidated, and had attained nearly its present dimensions.

I do not pretend in these remarks to have thoroughly discussed the cases of the other planets, and have only drawn attention to a few salient features; in the paper itself the subject is considered at greater length. It will, however, I think, be admitted that the theory agrees with some remarkable facts in the solar system.

G. H. DARWIN.

AZTEC RUINS IN NEW MEXICO.

THESE ruins are highly interesting, as showing the state of civilization of this ancient race. The ruins of Pueblo Bonito, illustrated herewith, are the largest, and, in some respects, the most remarkable of all. Its length is 544 feet, and its width 314 feet. By referring to the plan it will be seen that it only roughly approximates the usual rectangular shape. The two side wings are parallel with each other, and at right angles with the front wall. The left hand wing consists of three rows of rooms, 8 in each row, 12 to 15 feet wide and from 12 to 20 feet in length. The outer walls are entirely demolished, but some of the interior walls reach to the top of the second story. In front of this wing and facing the court are the remains of what was probably three circular, partially subterranean rooms, probably *estufas*. The section adjoining this wing is in the shape of an almost perfect quarter-circle, and consists of five tiers of rooms, with nine rooms in each.



AZTEC RUINS IN NEW MEXICO.

The walls are standing quite generally as high as the second story. The middle section is the most ruinous of all, but the great depth of the *debris* which covers several perfect rooms indicates that it originally possessed an equal height with the adjoining walls. The outer wall thus far is entirely ruined, hardly a stone remaining in place, but in the section that lies between the central line of *estufas* and the right-hand wing it rises up to the fourth story, and is in a remarkably well preserved condition. Several of the interior parallel and transverse walls are also standing fully 30 feet high. Many of the *vigas*, which are in excellent preservation, still retain their places and protect a number of rooms on the first floor. The outer wall of the east wing is in fair preservation, while the interior walls are in excellent order for at least two stories; the apartments in this and in the adjoining section are of unequal size, and the walls of the ground-floor are of a firm massiveness that has preserved them remarkably well. Within this wing are two *estufas*, one of which came up with and formed a portion of the second story. Across the front of the court there are two tiers of rooms about 25 feet in width, their fallen walls making a mound of *debris* 5 to 8 feet in depth, indicating that they were of considerable height. Every transverse wall could be easily distinguished. Interrupting this about midway is a solid parallelogram 65 by 115 feet in dimensions, in which are two *estufas*, each 50 feet in diameter.—*Min. and Sci. Press.*

THE CANARY ISLANDS.

IN an essay on the evolution of volcanic rocks in general and of those of the Canaries in particular, by Don Salvador Calderon, of Arana, just published in the Annals of the Society of Natural History, he reduces all the rocks of the Canary Islands into two grand categories—a sandine-amphibole group and a plagioclase-augite group. Thus, out of a paste of augite and plagioclase he conceives that all the rocks of the second category may have been formed, with the addition of other accidental minerals, and by a variation in the proportions. So that at the end of the one series he places a nepheline-basalt containing sandine, and he traces a gradation from this rock through the disappearance of the sandine, the successive appearance of the hauyne and olivine, and the final predominance of the latter mineral, till he finds the felspathic basalts, dolerites, and modern lavas. He discusses the evolution of volcanic rocks under four periods: 1. The Lava period, in which section he treats of the vitreous fluidity of lava, the influence of temperature, pressure, and water in the formation of the rock, and the possibility of an arrangement or liquidation of the component elements of the lava while still melted within the volcano. The Refrigeration period. Here he discusses the crystallization of the lava, noting particularly the results of the evaporation of the interstitial water, the formation of the "micro-fluctuation" structure, the development of porphyritic crystals, and the effects of sublimations. 3. Changes in the rocks after solidification; divided into (1) mechanical, which include fractures on the great scale, cracks in the paste of the rocks, fissuring of the crystals, and the formation of cavities and globules; (2) physical, embracing the phenomena of devitrification; and (3) chemical, under which are placed serpentinization, zeolitization, natrolitization, etc. 4. The Decomposition period. Under this heading the author, citing the researches of Durocher, Bischof, and Delesse on the prepermeability of rocks by meteoric water, and the changes thereby produced, gives a brief account of the nature of the alterations of some of the more prevalent minerals in the rocks of the Canary Islands and elsewhere. The paper is illustrated by a few drawings of microscopic structures.

CULTURE OF ONIONS.

FORTY years ago it took twenty-five men and four teams one day to sow an acre of onions; now, two men, a boy, and one horse in two days will do the same work in a much better manner. The great difference is in fitting the soil. Formerly we put on a very heavy coat of manure in the fall and plowed it under six or eight inches. In the spring we plowed and cross-plowed to mix the whole mass, making a load of lumps for every load of fine earth. Now we do not plow in the spring, but let the frost do the pulverizing, and only mix the manure with two or three inches of the surface, taking less than one-quarter to produce the same. For the last ten years my practice has never failed. I plow the land just before winter, not deep (say four inches), and if the land is not level I plow across, so the rains will not run down the furrows and wash off the soil. In the winter, or at any time after the ground freezes, and before it thaws in the spring, I put on a light covering of fine barnyard manure, spread evenly over the land. In the spring, after a few dry days (or the first day it is dry enough), I let a boy with horse and cultivator go across the furrows, pulverizing and leveling the ground in a strip two rods wide. We then go over with a light harrow; after this we use a pulverizer. This is made of four planks 4½ feet long and 16 inches wide. I bolt the first plank on two cross-pieces at the back, and raise the back side 2 inches, or the thickness of the plank. I then put on the next plank and lap it over the first far enough to put a bolt through both and through the cross-piece. In the same manner I put on the four planks.

This is drawn over a few times, and will break the lumps and level the surface, which will save most of the labor of raking. After this one man with a rake will level and make the surface smooth. A man with a drill will sow in rows, 14 or 16 inches apart, as fast as the land is prepared. When the onions are up so the rows can be seen, we go over with hand cultivators, and when the weeds appear in the rows, we go over with a hoe and keep clear of weeds. Success cannot be expected unless this is done.

N.B.—Plow the land late in the fall and you will destroy the cut-worms. Sow the onions early and the onions will all "bottom," and there will be no "scullions," as they are called, which are merely unripe onions.—*W. R., in Country Gentleman.*

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